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C. B. & Q. Shops at West Burlington

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Western Editor, *American Machinist*

Time-saving methods and equipment in an exceptionally well-organized shop—Group system of layout used—Planer chucks for cylinders—Machining links and side pieces

AMONG the largest and best-equipped railroad shops in the country are the shops of the Chicago, Burlington & Quincy Railroad at West Burlington, Iowa. The buildings and tracks occupy 92 acres of a 350-acre plot, plenty of room being thus provided for future expansion. The main building, which houses the machine and erecting shops, is 310 ft. wide and 792 ft. long and is laid out with three longitudinal pits which, according to the original plans, would have been on the south side of the shop. At the time of construction, however, it was decided to add another 70-ft. bay on the south side of the building—a decision that has long since been justified. The group system has been followed throughout in arranging the machine shop equipment, departments having been allotted for each of the major parts as far as possible. The policy of

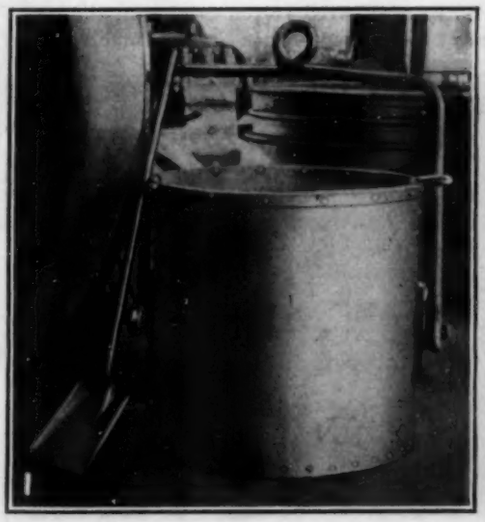


Fig. 1—Chips are dumped into steel barrels. Fig. 2—Tool-forging and tempering department

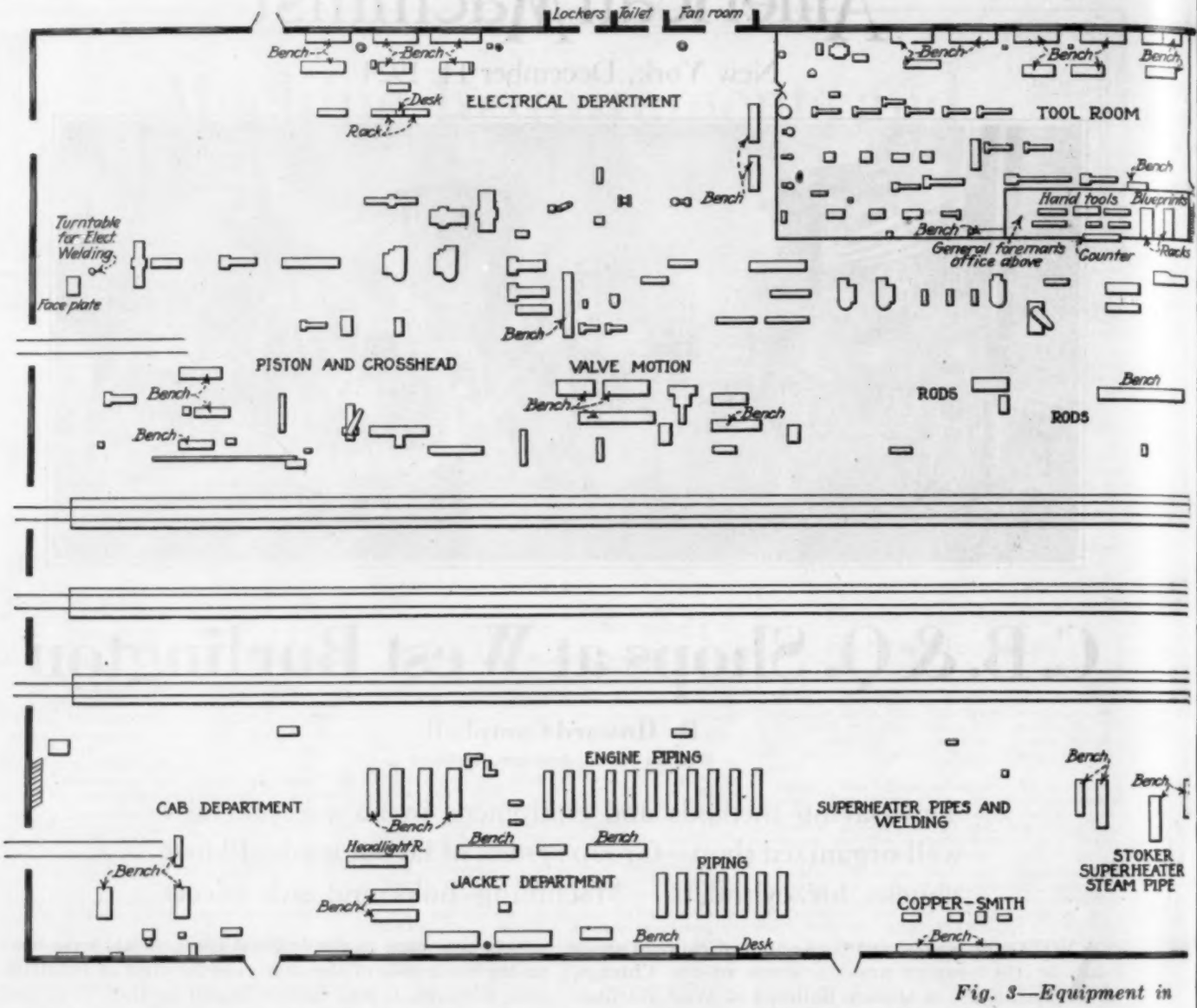


Fig. 3—Equipment in

finishing all parts in the machine shop and then delivering them to the erecting shop to be assembled is being followed generally on the Burlington lines.

The heavy machines are located in the bay that parallels the erecting shop on the north side, with the cylinder and frame machines and the stoker, superheater, steam pipe, engine piping and cab departments in the south bay, arranged in progressive order. The extra bay contains the light machine departments, toolroom, bolt machines and brass finishing, electrical, air pump, welding, brake and spring-rigging departments. The erecting bay is served by two 250-ton cranes having 100-ft. span, each crane being supplemented by a 25-ton hoist. There are also three 15-ton cranes in the erecting shop and two 15-ton cranes in the machine bay

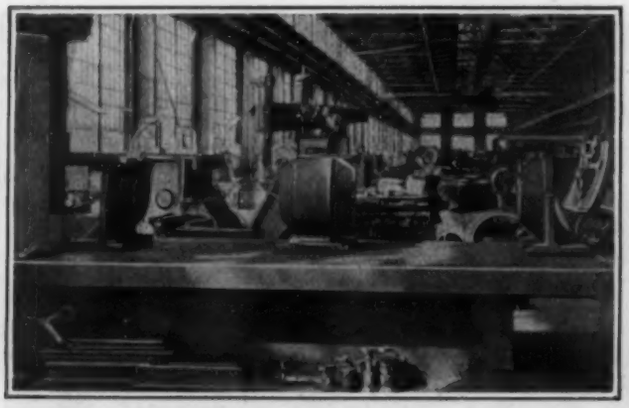


Fig. 4—Chucks in which cylinders are located

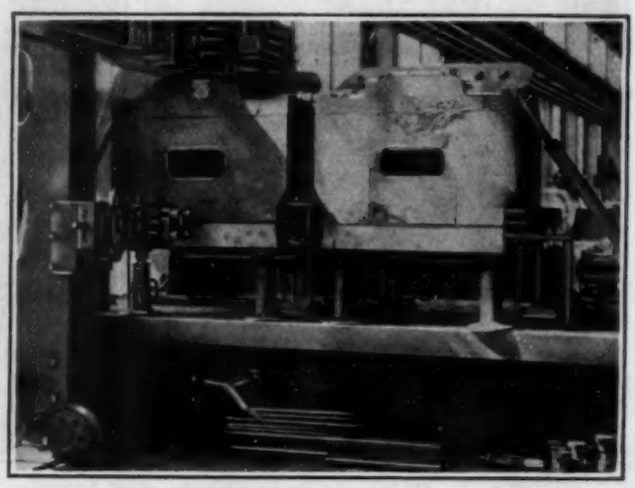
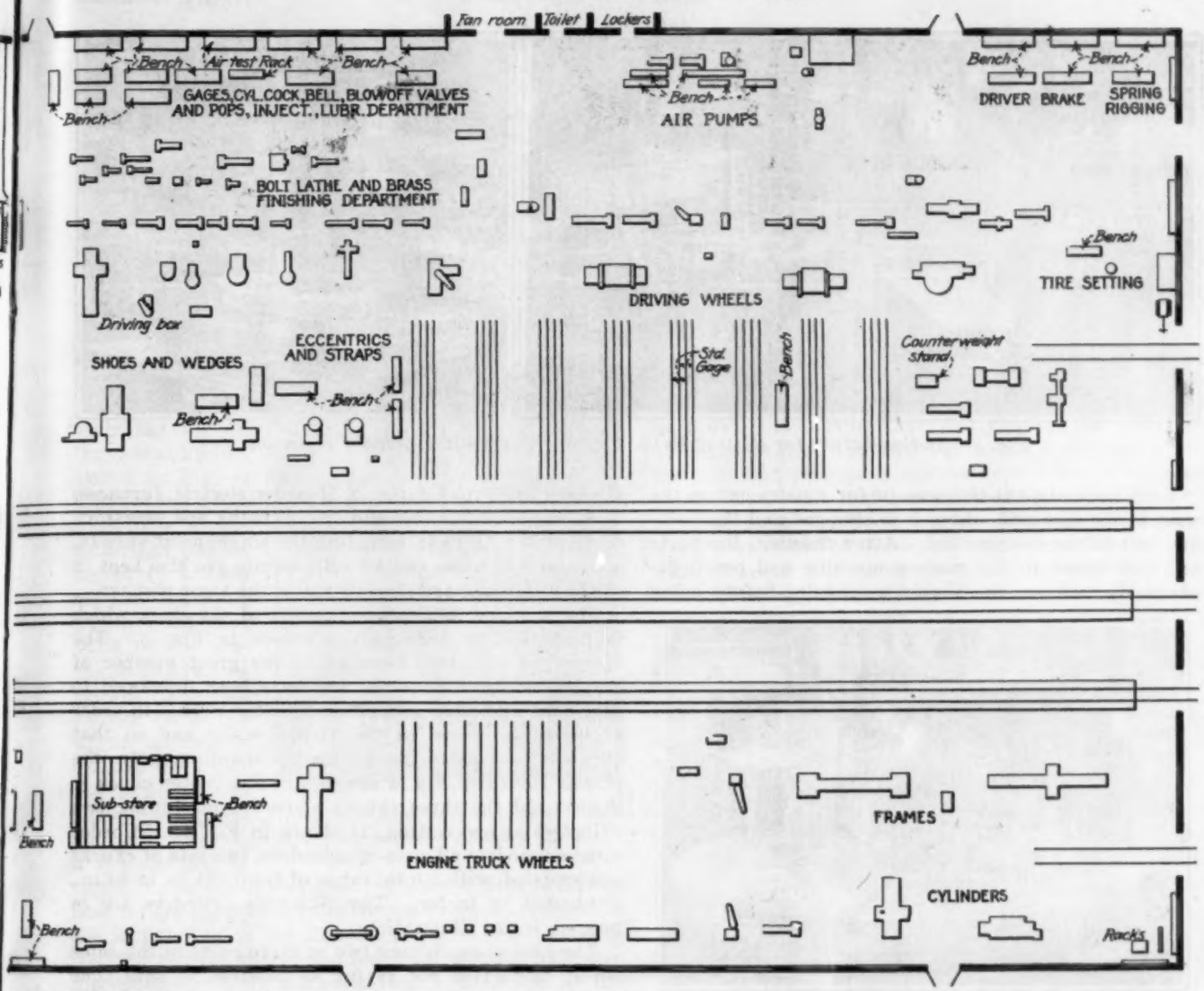


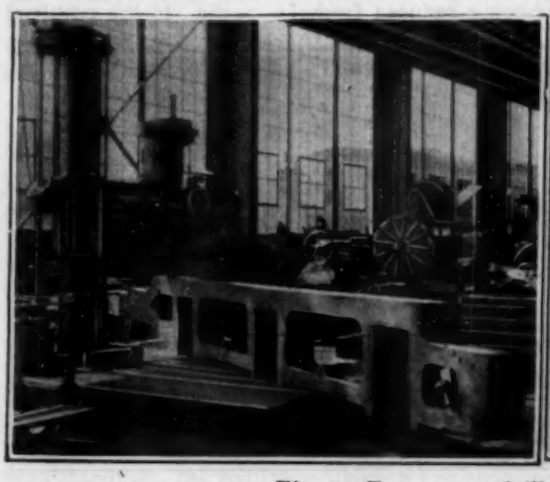
Fig. 5—Two cylinders are planed at a setting



main building

either side of the erecting floor. The shop not only handles classified locomotive repairs, but also repairs road equipment and manufactures parts to be used in this and other shops throughout the system.

Boiler tubes and tender frames are handled in a separate building, the tubes being passed through according to a progressive system that will be described in a later article. The blacksmith shop is also housed in a separate building, 90x250 ft., the major equipment including 11 steam hammers, 4 Bradley hammers, four forging hammers (of which the largest is 3-in.), a No. 26 Williams & White bulldozer and a double-end punch and shear. It is also well equipped for doing pressed steel car work.



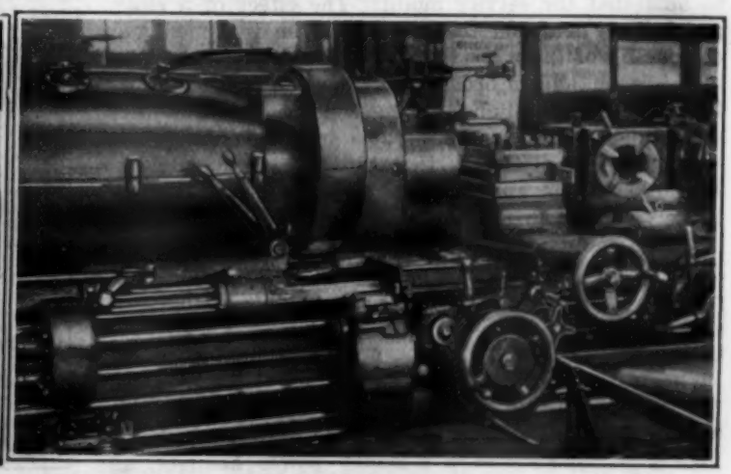


Fig. 6—Frames are drilled in pairs. Fig. 7—Taking a 1¼-in. cut

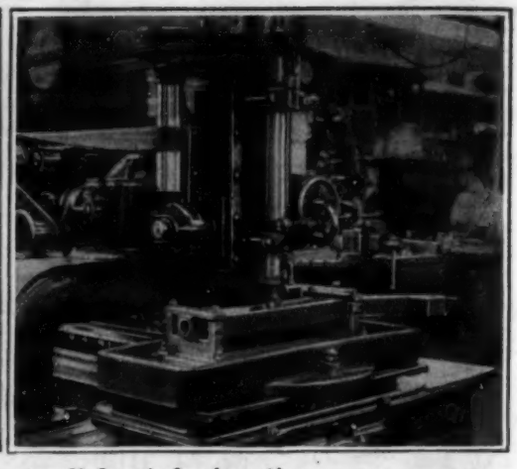


Fig. 8—Radius-fixture for slotting links. Fig. 9—Newton link-grinder in action.

Each locomotive that comes in for repairs enters the shop at the east end, where it is stripped and the parts are sent to the cleaning vat. After cleaning, the parts are distributed to the various machine and bench departments and are thoroughly overhauled before being

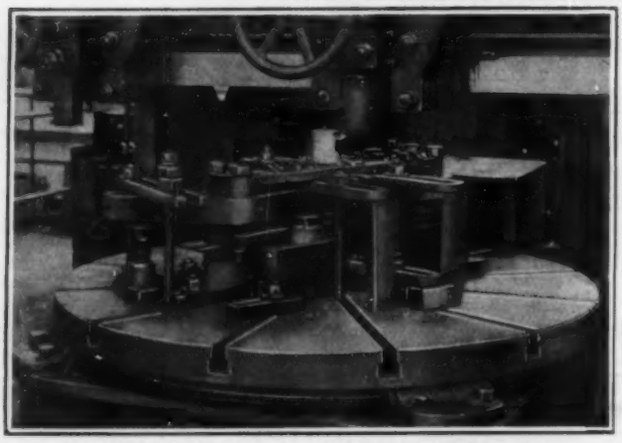


Fig. 10—Turning bearing on link side-piece.

sent to the erecting floor. The engine is kept moving through the shop as the work progresses and as other engines come in for repairs, the floor and bench assembly departments being arranged progressively so that by the time the engine reaches the west end of the shop, it is completely reassembled and is ready to be tested for service again. The effect of a clean and orderly shop on the morale of the workmen and the quality of the work that is turned out is recognized in this shop, and in order to further the idea of orderliness, the brake- and spring-rigging, boiler tubes, steam pipes and other small parts are kept off the floor by the use of platforms that can be moved about by a crane. Chips and shavings are dumped into steel barrels similar to the one shown in Fig. 1, a number of them being located at convenient places about the shop. Filled barrels are picked up by the crane and carried to the scrap bins which are outside at the west end of the shop.

The tool-forging and tempering department is placed in a corner of the tool room, an arrangement that divorces toolsmithing from blacksmithing and assembles all tool work in one department. The equipment, shown in Fig. 2, consists of a Beaudry power hammer, an anvil, a pneumatic cut-off for the smaller sizes of tool-stock, a brick tool forge, 2 Hoskins electric furnaces, 1 Furgeson oil furnace and the oil baths and accessory equipment. All tools, including the single-point variety, are issued on brass checks. Blueprints are also kept in the tool-crib and are checked out in the same manner.

The machine and tool equipment of the shop, which is first-class, is arranged as shown in Fig. 3. The feature of the shop, however, is the great number of special tools and methods that have been developed to save time and labor and produce better work. In order to locate cylinders on the planer easily and so that the tops and sides can be planed simultaneously, the chucks shown in Fig. 4 are used. The center chuck is double and the three chucks allow for machining two cylinders at one setting, as shown in Fig. 5. In order to accommodate all sizes of cylinders, two sets of chucks are supplied, with a total range of from 18¼ in. to 30 in., graduated by inches. Two S2A-type cylinders are in process in the illustration.

The idea of machining two or more parts in the same set-up is carried out as far as possible, to save time and handling. Fig. 6 shows two frames being drilled at one setting. Cylinders are drilled in pairs and another saving is made by finishing the boss on the end of the cylinder, which butts against the locomotive frame, with a facing tool while it is set for drilling. This was formerly done on the planer and required an extra setting.

The operation of turning a crosshead pin is illustrated in Fig. 7. A Libby lathe is used for the job and the piece is being reduced from 7½ in. dia., to the required

Fig. 11—Finished bearing locates piece for concentricity

size, most of which is removed in the first cut. An 8-P. thread is cut on the piece with the Geometric die shown in the machine-turret, the whole operation taking approximately one hour. The former method of centering the piece, turning it between centers and threading it with a single-point tool would have nearly doubled this time.

Both forged and cast-steel links are used, but as the forged links are solid, they require slotting for the blocks. The piece is laid out for the slot and a row of 1¼-in. holes is drilled just inside the layout line. Then a 3¼-in. hole is drilled at each end of the layout and the scrap piece is removed in a solid block. The link is then sent to the slotter and is further finished with the aid of the attachment shown in Fig. 8. The attachment consists of a pedestal that can be bolted to a base set into the floor, and a rail that bolts to the machine table, as shown. The rail swings on a pin in an adjustable block in the top of the pedestal, the block being attached to a nut on a screw that is turned by means of a ratchet. A tram is used to set the boss for the dimension from the center of the pedestal to the layout line on the link, then the boss is locked in position and the rotary and longitudinal table feeds are disconnected. Only the cross-feed is used and as the table feeds across the machine, the rotary table, bearing the work, swings on the correct radius. The job requires approximately 1 hr. 10 min. to set up and two pieces are finished at a setting, in approximately four hours. From $\frac{1}{32}$ in. to $\frac{1}{16}$ in. is left for the finish cut, which is taken out in the Newton link grinder shown in Fig. 9.

Fig. 12—Machining a trailer truck spring friction bearing plate

The bearings on the link side-pieces are turned in the Sellers boring mill illustrated in Fig. 10. A circle is laid out on the end of the bearing for locating, then the piece is clamped as shown. When the operation is completed, the piece is turned over, the bearing *A* is inserted in a locating hole in the base of the fixture and the opposite bearing is turned as shown in Fig. 11. Thus one lay-out does for both bearings and the bearings are concentric. The side pieces are then put on and the link is ready to be assembled to the engine.

Another handy fixture is that shown in Fig. 12, to which the trailer truck spring-equalizer friction bearing plates are clamped for finishing the bearing fits. The piece is clamped into the top of the fixture as shown, and the fixture is blocked up and clamped on the face that corresponds with the angle of the surface that is to be machined. Screws, with thumb-nuts and washers, prevent the block from slipping out from under the angle-face of the fixture. When half of the surface has been machined, the fixture is tilted in the opposite direction and the other half is finished.

Back-Shop Notes

By Frank C. Hudson

THE tire problem is one of the worst that confronts the average railroad motive-power department—especially on a road with many curves. Tires themselves have changed very little in ten, or even twenty years. The steel is not materially different, according to Lawford H. Fry, and every shopman knows it is about the hardest stuff that comes into the shop to machine. Twelve feet a minute is probably the average cutting speed, with the best tools money can buy.

Then there is the waste of tire material by turning down tires because the flange has worn thin. I saw, only the other day, a pair of 66-in. tires being turned in a new wheel lathe that was ripping the metal off at a good rate. The cut was about a half-inch deep and the feed perhaps a quarter inch. Not a flat spot on the tire. All that metal, which meant miles and miles of wear, was being sacrificed because the flanges were worn thin. And because they were thin, a half-inch of tread had to be sacrificed in order to leave material enough for a flange of the required thickness.

Some shops I've seen are building up the worn treads by either the arc or acetylene process. The steel wizard tells us it is criminal and that all sorts of dire disaster is liable to happen. But many of these doctored tires are in use and giving good mileage, saving the awful waste of good tread material as mentioned before.

There have been, of course, some failures from built-up tire flanges. I don't seem to remember any practice that is quite one hundred per cent perfect. But the fact that even a few of these built-up tires give a good account of themselves, ought to warrant careful investigation of the process.

What Happens in Welding

Here is one of the many cases where there is a crying need for a railroad testing-laboratory that shall serve all the railroads. The problem is one that seems fairly common to all roads, and it should be studied for the benefit of them all.

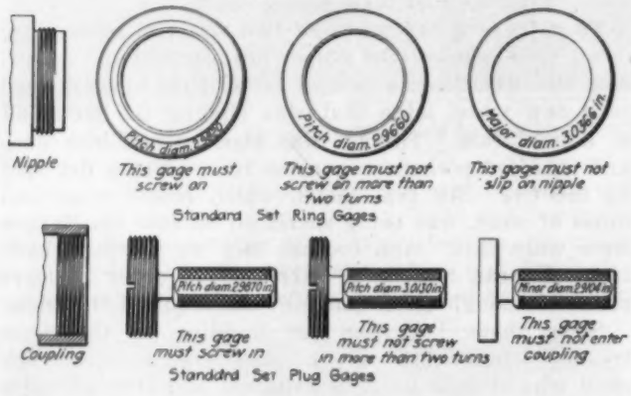
Let the steel sharks make all kinds of tests with all kinds of welding or filling in methods. There is no question as to the local heating to the fusing point set up severe internal stresses. But there may be a way of relieving these stresses by annealing, even without removing the tire from the wheel center. The fact that some flange-filled tires are giving good service without annealing, shows that the stresses are not always fatal. The main this is to *know what happens* under this process and whether or not it is safe practice for the railroads. If it is, they should all use it when conditions warrant. If it is not safe, it should be taboo.

With flat spots on tire treads, turning is probably the only thing to do. But it certainly seems like a shameful waste of good material to turn off a good tread for a thin flange. Then too, there is the machine overhead of a costly wheel-lathe to be considered.

The cost of research work along this line can be paid for by the salvaging of a few hundred sets of tires. The cost of tires with only normal wear is considerable, because they can only be worn to about half the original thickness. And when we waste any of this good tire tread we are throwing money away.

Standardized Hose Couplings

AFTER every great fire, in which the aid of other cities has been necessary, the need for standardization of fire-hose couplings has been made evident in a forcible manner. The great Boston fire in 1872 brought about the realization of the necessity of standardization when fire apparatus from other cities was greatly handicapped by the difference in hose couplings. And yet as late as the great Baltimore fire, much valuable property was destroyed because the hose couplings used


Nipple
This gage must screw on
This gage must not screw on more than two turns
This gage must not slip on nipple
Standard Set Ring Gages
Coupling
This gage must screw in
This gage must not screw in more than two turns
This gage must not enter coupling
Standard Set Plug Gages

in Philadelphia were not the same as those used in Baltimore. Although numerous attempts had been made previously, the unnecessary loss in the Baltimore fire was the incentive which led to the National Board of Fire Underwriters to inaugurate a movement for real standardization of fire-hose couplings.

As the result of a careful study of existing hose couplings, over 300 in all, the standard for the commonly used 2½-in. hose has been adopted as 3⅛ in. outside diameter and 7½ threads per in., this being a compromise which will save the greatest number of couplings now in use. Needless to say this is neither the size nor the pitch that would have been chosen if a new coupling had been designed.

Some of the hose couplings in use will interchange with the standard, after a fashion, either by being enough larger so that the 8 threads per inch will screw on the 7½, or by being a very loose fit with the same thread. Others are so much larger that the nut rides on top of the thread on the nipple. The present standard in which the National Screw Thread Commission, the U. S. Chamber of Commerce and A.S.M.E., the Bureau of Standards and many other bodies are interested has been made compulsory in some states and legislation is pending in others to the same effect.

Many of the couplings now in use can be made over by the use of suitable taps and dies, and a set of tools for this purpose is now being made by the Greenfield Tap and Die Corp., the engineers of which have devoted much time to the subject. Both roughing and finishing taps and dies are used, while in some cases a roller expander makes it easy to enlarge the diameter of a coupling to standard size and avoid the necessity for throwing it away. In some instances, couplings with 8 threads per inch can be recut to 7½ threads and so become interchangeable with the standard. Go and not-go gages are also provided.

There is no attempt at close fits, because hose couplings must go together freely in all kinds of weather and under all conditions. There is a liberal allowance or clearance between the mating parts and the tolerance is as wide as can be safely allowed. The minimum looseness is 0.015 in., the tolerance on both parts being 0.016 in. Even so some hose-coupling makers object to the standardization, preferring for one reason or other to continue their great variety of couplings, making them from samples rather than from standard gages.

The hose coupling is a good example of the advantage of standardization, even if the standard adopted be a compromise and not at all ideal. It is far better to have hose couplings that will interchange in emergencies, regardless of the size, than to delay standardization until an ideal size can be adopted. For, after all, it is interchangeability and not ideal dimensions, that we need. And it is pleasing to note that over 800 fire-protected cities are now completely standardized on hose couplings.

The standards adopted are given herewith for reference.

Table I—Limiting Dimensions for Coupling Threads (Internal)[1]

Nominal Size	No. of Threads per in.	Min. Major Diameter[2]	Pitch Diameter		Minor Diameter	
			Max.	Min.	Max.	Min.
2.500	7.5	3.0836	3.0130	2.9970	2.9424	2.9104
3.000	6.0	3.6389	3.5486	3.5306	3.4583	3.4223
3.500	6.0	4.2639	4.1736	4.1556	4.0833	4.0473
4.500	4.0	5.7859	5.6485	5.6235	5.5111	5.4611

Table II—Limiting Dimensions of Nipple Threads (External)[1]

Nominal Size	No. of Threads per in.	Major Diameter		Pitch Diameter		Max. Minor Diameter[3]
		Max.	Min.	Max.	Min.	
2.500	7.5	3.0686	3.0366	2.9820	2.9660	2.8954
3.000	6.0	3.6239	3.5879	3.5156	3.4976	3.4073
3.500	6.0	4.2439	4.2079	4.1356	4.1176	4.0273
4.500	4.0	5.7609	5.7109	5.5985	5.5735	5.4361

"[1] The largest nipple is purposely made smaller in diameter than the smallest coupling in order to insure a fit loose enough so that these threads can be assembled quickly regardless of the presence of dirt, burrs, bruises, etc.

"[2] These dimensions correspond to the basic flat (ip). The profile at the major diameter of the coupling, produced by a worn tool, must not fall below the basic outline, but a new tool may be made with a flat at the point as small as $\frac{1}{24}$p.

"[3] These dimensions are figured to the intersection of the worn tool arc with a centerline through crest and root. New tools may be made to give a minimum minor diameter of the nipple as small as that corresponding to a flat of $\frac{1}{8}$p."

Table III—Limiting Dimensions of Field Inspection Plug Thread Gages for Couplings (Internal)

Nominal Size	No. of Th'ds per inch	"Go" or Minimum Gage				"Not Go" or Maximum Gage			
		Major Diam.		Pitch Diam.		Major Diam.		Pitch Diam.	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
2.500	7.5	3.0846	3.0836	2.9980	2.9970	3.0836	3.0826	3.0130	3.0120
3.000	6.0	3.6399	3.6389	3.5316	3.5306	3.6389	3.6379	3.5486	3.5476
3.500	6.0	4.2649	4.2639	4.1566	4.1556	4.2639	4.2629	4.1736	4.1726
4.500	4.0	5.7869	5.7859	5.6245	5.6235	5.7859	5.7849	5.6485	5.6475

Table IV—Limiting Dimensions of Field Inspection Ring Thread Gages for Coupling Nipples (External)

Nominal Size	No. of Th'ds per inch	"Go" or Maximum Gage				"Not Go" or Minimum Gage			
		Pitch Diam.		Minor Diam.		Pitch Diam.		Minor Diam.	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
2.500	7.5	2.9820	2.9810	2.9104	2.9094	2.9670	2.9660	2.9114	2.9104
3.000	6.0	3.5156	3.5146	3.4223	3.4213	3.4986	3.4976	3.4233	3.4223
3.500	6.0	4.1356	4.1346	4.0473	4.0463	4.1186	4.1176	4.0483	4.0473
4.500	4.0	5.5985	5.5975	5.4611	5.4601	5.5745	5.5735	5.4621	5.4611

Notes: (a) The major diameters of the ring gages are undercut beyond the nominal major diameters to give clearance for grinding or lapping.

(b) The minor diameters of plug gages are undercut below the nominal minor diameter to give clearance for grinding or lapping.

(c) The allowable variation in lead between any two threads not farther apart than the length of engagement is plus or minus 0.0005 inch.

(d) The allowable variation in one-half angle of thread is plus or minus 10 minutes.

(e) The diameters of the "Not Go" Field Inspection plain Plug Gages are the same as those given for the maximum minor diameter of couplings given in Table I.

(f) The diameters of the "Not Go" Field Inspection plain Ring Gages are the same as those given for the minimum major diameter of nipples given in Table II.

X-Ray Examination of Metals at the Watertown Arsenal, Watertown, Mass.

By T. C. Dickson*
Watertown, Mass.

Preventing the acceptance of unsound metal components—Method of protecting persons—Use of apparatus justified by results so far obtained

SOUND metal in many articles of ordnance is essential to the safety of personnel, particularly in those articles designed with a factor of safety very little in excess of unity. The service utility of many articles of ordnance depends upon their lightness, and a definite knowledge of the character, location, and size of defects in many components materially assist the ordnance engineer in meeting service requirements.

With the hope of preventing the acceptance into the military service of unsound metal components and of assisting the ordnance designer to meet service requirements in regard to lightness, a 280,000-volt X-ray equipment was put into operation in the laboratories at the Watertown Arsenal in September, 1922.

To insure protection to persons, the room in which the equipment was installed was lined with lead ¼ in. thick and all joints and securing screws were similarly covered. A lead-lined periscope permits the operator to view with safety the Coolidge tube when making an exposure.

The first few months of operation were devoted to learning the technique, the practical limits of the equipment, and time of exposure required for different thicknesses of metal, and to determining the character, location and sizes of defects revealed by the films.

When about 200,000 volts are impressed on the Coolidge tube an exposure of about one minute is required for 1 in. thickness of steel, about five minutes for 2 in., and about thirty minutes for 3 in. Efforts to obtain clear films up to 250,000 volts impressed on the Coolidge tube with a thickness of steel much in excess of 3 in. have not been successful.

Practical Value of Equipment

The experience so far had with the equipment has demonstrated that it has great practical value in showing the methods by which sound steel castings can be produced, and as an instrument of inspection.

It is the practice of the Watertown Arsenal to make one casting from each pattern, which is X-rayed. As the films, when properly interpreted, reveal the character, size, and location of all defects, it has generally been found possible by changes in method of molding, location of risers, etc., to obtain castings free from defects or to locate them where they do no harm. If the method of molding is changed, one or more castings made in accordance with the change are X-rayed to verify the accomplishment of the object desired, and a certain percentage of those made are also filmed for verification.

The removal of all defects or their location where they do no harm enables a material saving in the weight of castings to be made. The cost of making X-ray films of castings is far less than the cost of cutting up castings to ascertain their soundness. The loss of the cost of machine work performed on castings subsequently rejected for revealed defects has been practically eliminated. Users of steel castings will appreciate the saving that results from the practical elimination of lost castings that have been partially or wholly machined, and from the reduction in the weight of steel castings. It is considered that the experience had with this equipment justifies the Ordnance Department of the Army in adopting it as part of its regular inspection apparatus.

How the Apparatus Is Used

The practical utility of the equipment can best be shown from lantern slides. It should be borne in mind that those X-rays which pass through a defect, and therefore through a less thickness of metal, reach the film with greater intensity, and therefore form a much darker spot on the film, the outlines and size of the spot corresponding closely to those of the defect. When a film showing defects is photographed to make a slide, the black spots showing defects appear on the screen as light spots.

The experienced personnel can tell from X-ray films of steel castings the location, approximate size and shape, and, with considerable certainty, the cause of defects. Occluded sand, cavities resulting from incomplete oxidation of the metal in the furnace, cavities formed by gases entering the metal during solidification from the core and mold, piping or shrinkage cavities resulting from inadequate feeding from risers during solidification, cracks caused by unyielding cores or failure to promptly relieve the mold, welding and imperfections in welding and burnt-in metal can be individually detected.

A constructive use of the knowledge obtained from films of castings enables articles to be designed and methods of molding to be used that either produce sound castings or locate defects where they do no harm. The production of such castings reduces to a minimum subsequent rejections.

When films of each element, solid solution, etc., found

*Colonel, Ordnance Dept., U. S. A.
Presented at the annual meeting of the American Society of Mechanical Engineers, New York, Dec. 1 to 4.

in steel are obtained, it will be practicable to determine from the film of a sample taken from an ingot the elements, etc., contained therein. It is hoped that a method will be found for determining quantitatively each solid solution in steel.

The meager use so far made of the diffraction X-ray equipment in the Watertown Arsenal laboratories shows that it is possible to determine what elements, solutions, etc., are present in metal, to determine the geometrical figure in which the atoms of each element, solution, etc., are arranged, and the distance between the atoms, both with a sample stressed and unstressed. The results so far obtained justify the prediction that our knowledge of metals will be wonderfully increased by the results obtained from this equipment. The diffraction apparatus shows changes in fundamental structure caused by (*a*) cold working, (*b*) heat treatment, and (*c*) alloying with various metals. Changes in structure thus obtained should be correlated with physical properties determined by physical test.

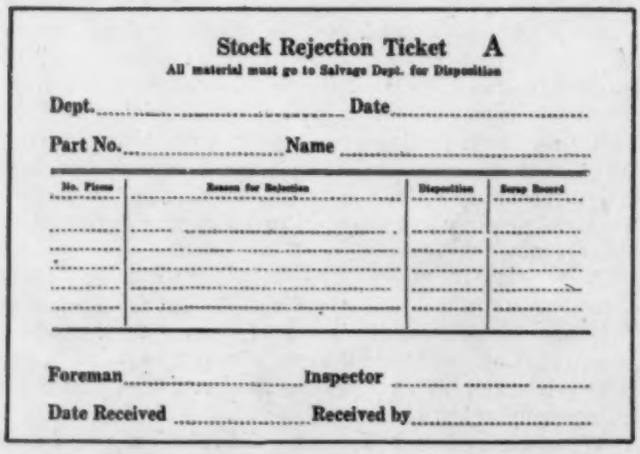
Salvage Control by the Inspection Department

By A. H. Frauenthal
Chief Inspector, Chandler Motor Car Co.

THE SALVAGE department must be handled differently in different businesses. However, it seems safe to say that with few exceptions salvage departments should operate under the head of the inspection department. No items come under the scope of the salvage department that are not in some way irregular or thought to be irregular. The inspection department is or should be more familiar than any other single department with the qualifications necessary for each job and this information must be readily available to the salvage department. Operation of the salvage department in connection with the inspection department also eliminates considerable duplication of tools, blueprints and other equipment. The standards of quality should be interpreted in the same way by both inspection and salvage departments. If these standards or their interpretations arise from the same source there is more general agreement, and controversies as to what constitutes quality are eliminated.

The functioning of the salvage department should merely be that of a clearing house for all material not strictly suitable for production. The actual work of salvaging or repairing of parts should be done by the production departments who regularly do this work.

If this work were actually done by the salvage department the material would have to be reinspected by the inspection department as it does not seem safe to allow the men doing the job to pass final judgment on the quality of the work. By this method the salvage department can farm out the work to the production department regularly doing this class of work and then have it returned to the salvage department for salvage inspection before placing it in production. This system also keeps the work more specialized as salvage machinists or the like would cover a very diversified type of work while the production men only cover a relatively small type of work.



Stock Rejection Ticket A

All material must go to Salvage Dept. for Disposition

Dept. ..... Date .....

Part No. ..... Name .....

No. Pieces	Reason for Rejection	Disposition	Scrap Record

Foreman ..... Inspector .....

Date Received ..... Received by .....

Salvage slip

Some Parts Must Be Scrapped

Of course, the salvage department cannot always repair material making it suitable for production, in which case it goes to scrap and in this connection it has proved to be a good plan for no one to be authorized to scrap any material except the salvage department.

The salvage department must also function properly in respect to records. It is through this department's records that scrap and repair losses are known. A simple and effective method of keeping in touch with the scrap losses as affecting both production and accounting departments has been worked out at our plant.

By our method any material rejected by the inspection department is considered as not being available for production purposes until such time as the salvage department may have disposed of it by some means which may make it available for production. This information is then immediately conveyed to the stock-chasing department which takes the necessary steps to replace the material. When material is rejected a stock rejection ticket is made out containing all information pertaining to this particular lot of material. A form of this slip is shown in the illustration. The salvage department, after disposing of the material, makes a record of this on the stock rejection ticket and copies are sent to the accounting and stock departments. This plan keeps a strict record of the scrap and the material available for production as no one is permitted to place any parts on the scrap pile except the salvage department.

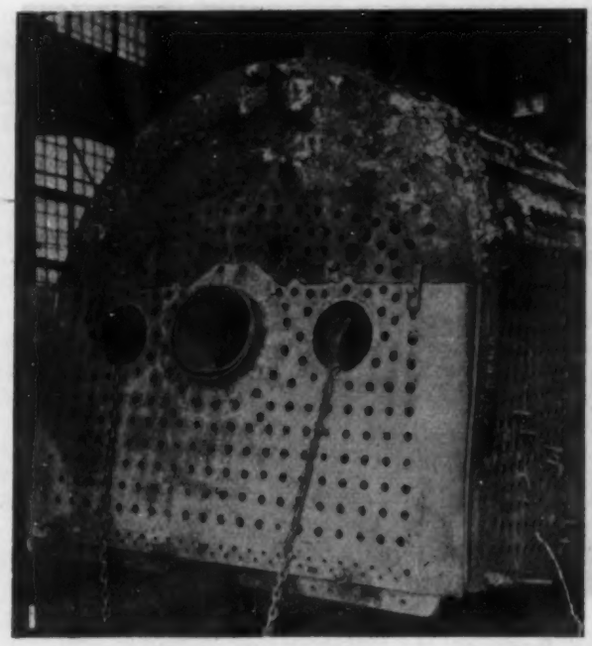
The inspector in charge of the salvage department must of necessity have a broad knowledge of inspection and mechanical work as it is his job to dispose of defective material to the best possible advantage. All salvage propositions of any particular importance, however, should be approved by the head of the inspection department and if the matter is of extreme importance, either in the judgment required or the amount of money involved, it should be passed on by a committee composed of the superintendent, chief engineer and chief inspector.

Important savings have been made by referring the disposition of valuable lots of material to this committee or a similar committee. Action of this kind is not only of value in working out methods of saving the particular lot of material from scrap but also functions with regard to eliminating any such errors in the future. This committee represents production, design and inspection and whichever branch requires improvement the proper authorities are present to see to it.

Where Machine Tools Are Made

Moline Tool Company
Moline, Ill.

Established 1903



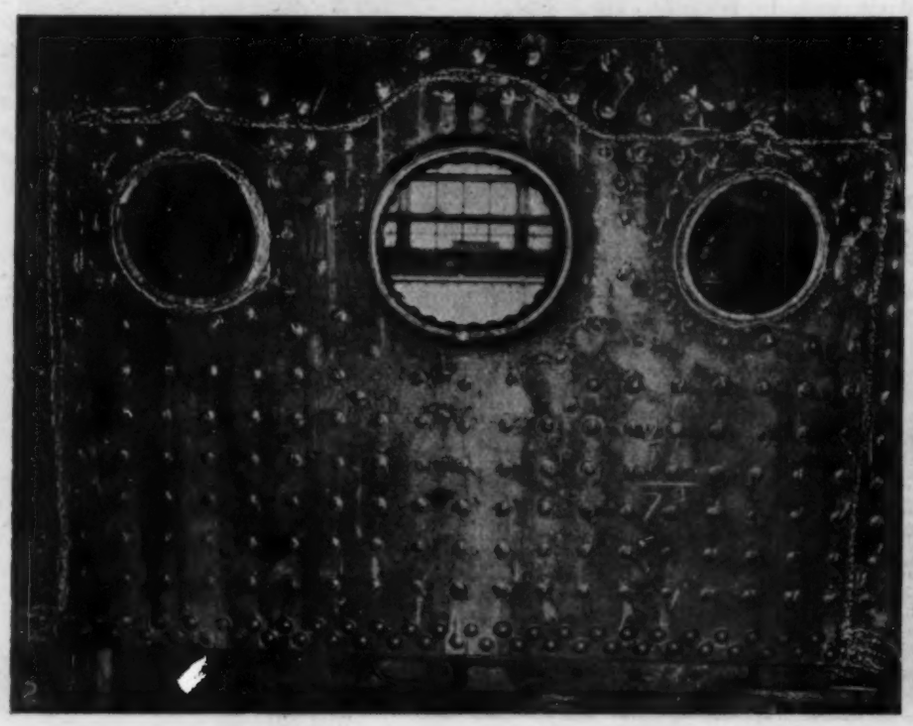
Arc Welding on Locomotive Work

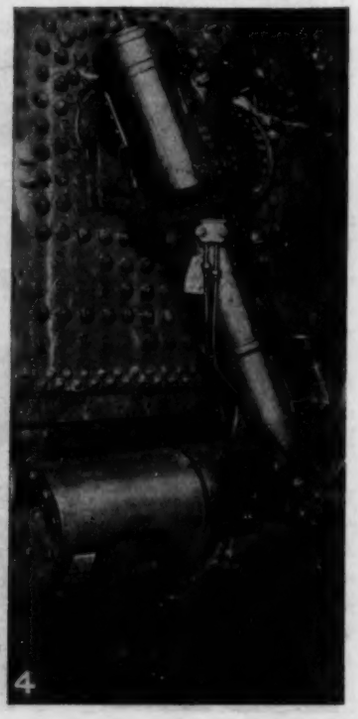
1—Locomotive back-head prepared for applying mechanical stoker. Plates will be beveled before welding. 2—Inside view of back sheet welded in place. Chalk lines show weld in sheet and around the stoker holes

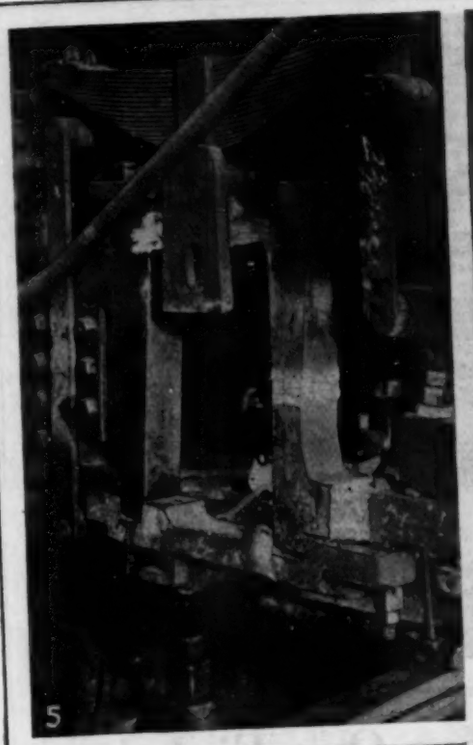
3—A butt weld on upper half of locomotive combustion chamber and a caulking weld at the side. The superheater flues are also welded. 4—Back sheet with stoker in position. Chalk mark shows where sheet is welded

5—Forged steel corner for pedestal jaw welded into place where shown. 6—Driving-wheel center salvaged by building up undersized hub by arc welding. 7—Boiler shell with flexible staybolt-sleeves arc welded to shell and bolts and caps in place. 8—Close-up view of arc-welded staybolt sleeves

Photographs by courtesy of the General Electric Co.



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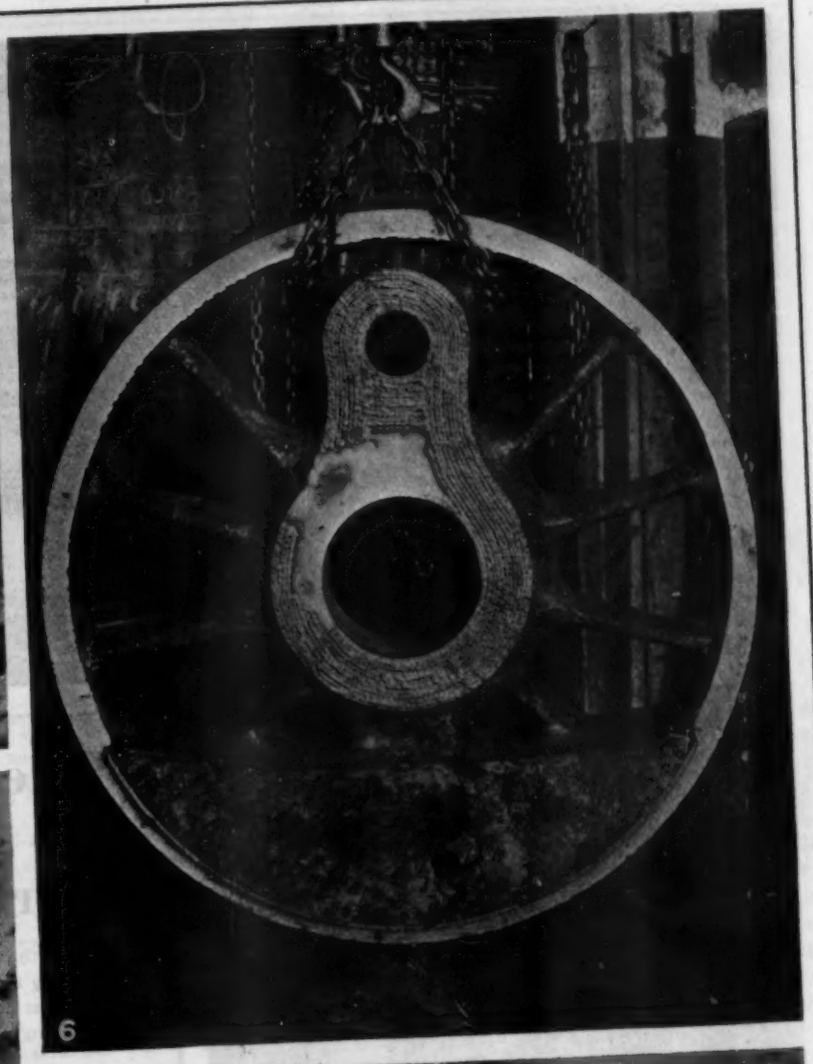
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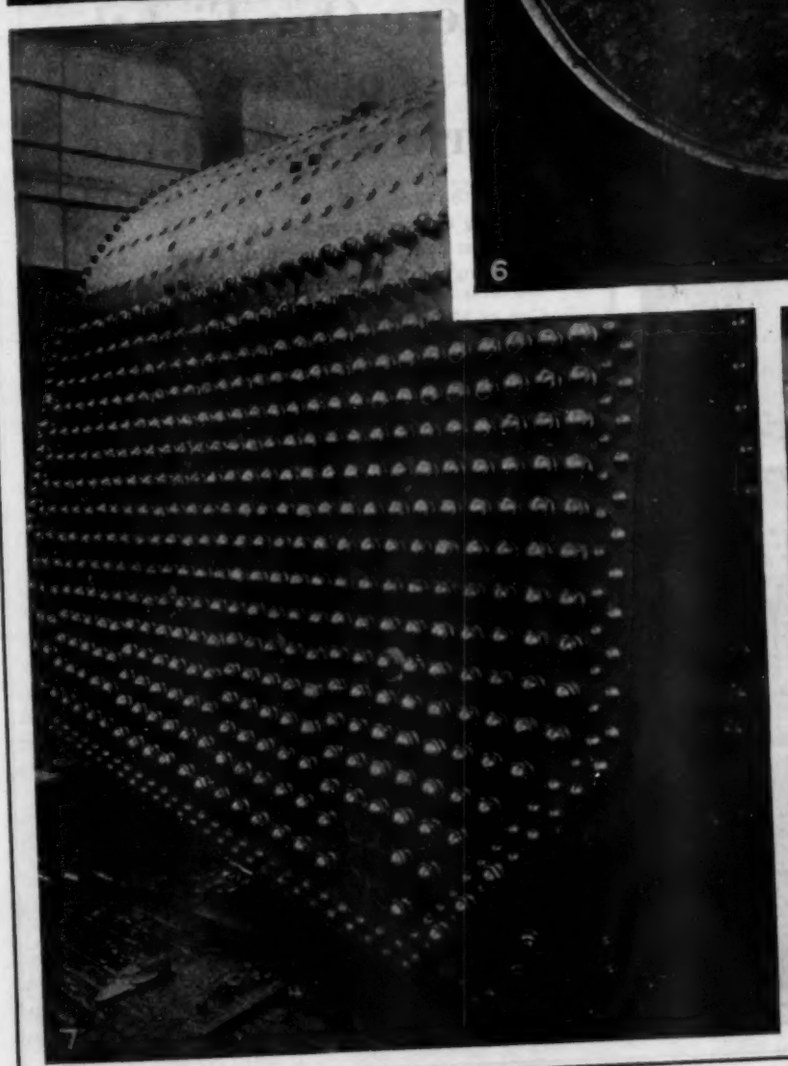
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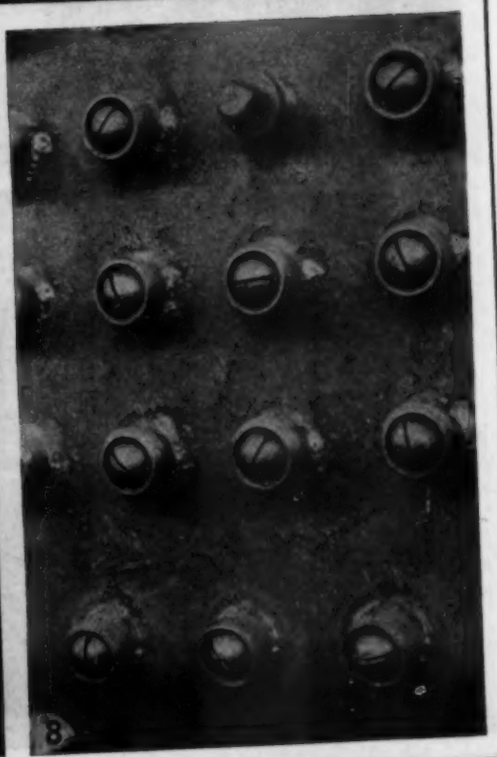
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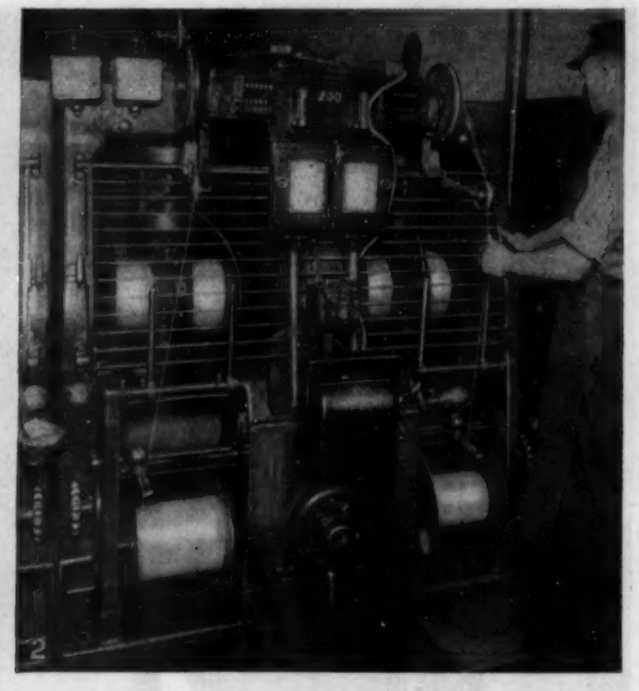


Where One-Eighth of the World's Lead Goes

1—Taping the single wire

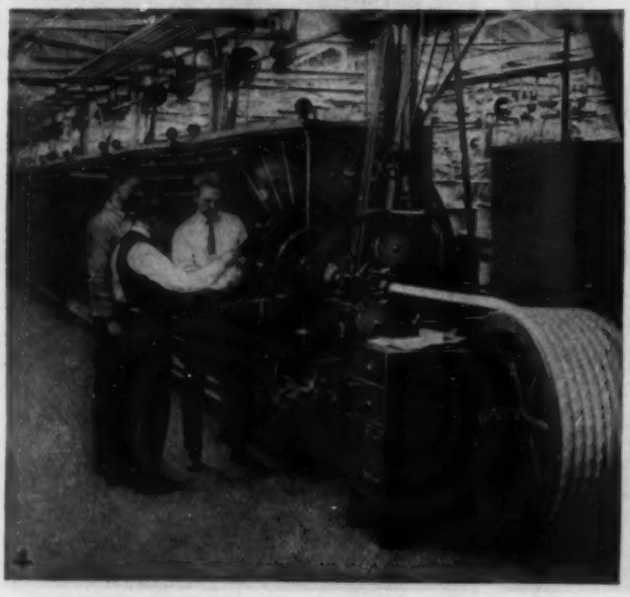
2—Twisting two wires together

3—The great lead-cable covering plant at Hawthorne, Ill.

4—Stranding pairs of twisted wires around the core of the cable

5—One of 13 lead presses which together make over 10,000 mi. of cable per year. Hawthorne consumes 145,000,000 lb. of lead per year or one-eighth of the world's output

Photographs copyrighted by the Western Electric Co.



Automotive Production

Making Satisfactory Piston Rings

By James McIntosh

Uniform tension essential in good piston rings—Correct mixture of iron and careful pouring and cooling necessary for best results—Grinding oversize with provision for closing

FAILURE to produce satisfactory piston rings is due largely to neglect of one or more essential elements at vital points between the foundry and the finished ring. Unless the finished ring has the necessary spring and can be put over the piston without breaking, the greatest accuracy as to size and finish is of little importance.

Since the methods used to solve a piston-ring problem some time ago may be of interest, some of the details will be given. One of the methods in use determined the length of the ring by snapping it into the cylinder, fitting the beveled ends by filing until the ends just

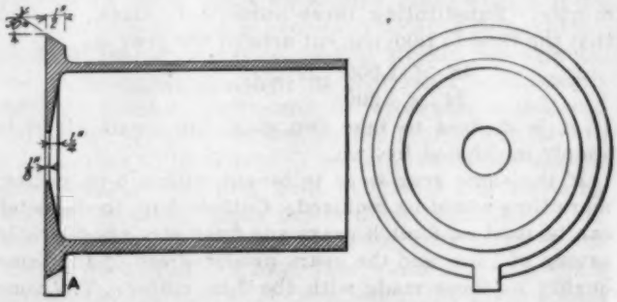


Fig. 1—Design of pot casting for rings piston

cleared each other. The ring was then sprung into the piston grooves and lapped to fit the cylinder bore. When the bearing was satisfactory the ring was removed from the piston and washed in gasoline. If enough metal had been removed in the lapping to open the joint appreciably, the ring was discarded. If the ends fitted properly it was again put in place.

This method ignores the distortion that takes place in putting a ring over the piston and especially in removing it. And while the groove holds the ring in position, there is more tendency for it to bind and wear on account of this springing.

The first step was to endeavor to eliminate the distortion by securing a ring of uniform spring and which would not take a permanent set in being sprung in and out of the grooves. In too many cases piston rings are cast from almost any old metal, when in reality they should be of special iron, run in the middle of the casting period and not dumped from the molds until cool. They should anneal in the molds, so as to avoid chilled spots. Such a method will give a spring of uniform temper.

The ring pot-casting should have allowance for a minimum of finish both inside and out. If the rings are eccentric, the casting should be the same, so that a uniform amount of metal will be removed at all points. A suitable design for a pot casting is shown in Fig. 1. The flange has a 30-deg. bevel on the edge to suit special jaws fitted to a universal chuck. It also has a lug at *A*, which indicates the thick side of the ring and acts as a driver. The internal flange resists the pressure of the chuck jaws and prevents distortion as well as vibration.

The first machine operation is to bore the inside and turn the outside to close limits, parting the rings with the usual multiple-tool set. It is advisable to use a multiple-tool boring head so as to maintain a close size with the minimum of tool wear. The multiple-tool boring head should lead the single-point tool on the outside to act as a steadying arbor. The outside cutting will then be done on a surface relieved from casting stresses.

The second operation is to finish the roughest side of the ring, using the best side against the magnetic chuck. This method tends to prevent any minute distortion that might come from the magnetic pull on a rough surface. The finishing of the second side follows, after which the ring is cut. A single, standard cutter is frequently used but a pair of slitting saws properly spaced will reduce the amount of metal cut, especially where the cut is made on the diagonal.

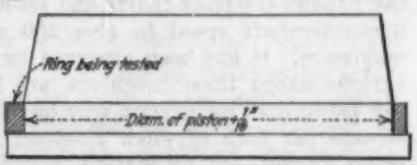


Fig. 2—Gage for testing elasticity of piston rings

Any variation in the diameter of the rings before grinding, affects the closing of the ring in the sleeve used for centering the rings on the grinding mandrel. For this reason the turned diameter should be held very close to size. The diameter of the centering sleeve should be figured from the circumference of the ring and $\frac{1}{32}$ in. should be added for small rings. This allowance takes care of any variation in the outside diameter of the rings and prevents distortion when they are as-

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sembled in the sleeve for placing on the mandrel. As this method does not completely close the slots, the rings must be ground to a slightly larger diameter to allow for closing when in the cylinder. The amount of excess diameter can be increased slightly if it is desired to fit the ends by filing. It has been my experience that grinding the rings with the ends slightly open has many advantages.

A simple test of the ability of the ring to pass over a piston without distortion may be made after the turning and boring operations. Cut a ring with a hacksaw, removing the proper amount of metal. Make a cone as in Fig. 2, with the large end $\frac{1}{8}$ in. larger than the diameter of the piston. Push the ring down over the cone and after removing it, note the width of the slot. If the slot is appreciably wider, the metal has not sufficient spring.

There is little danger of rings failing from being too hard if the metal can be machined at a fair rate of speed.

The sleeve should be made of cast iron and light in section with a band at each end to help keep it round. The bands should have lugs, which should be slit through lengthwise with a $\frac{1}{8}$-in cutter. Use a $\frac{1}{2}$-in. washer on the clamping bolt which will allow the slot to close $\frac{1}{8}$ in. and clamp the sleeve on the washers. Then finish bore and grind to the size of the outer ends of the collars on the mandrel so that it can be centered. Make the inner ends of the collars the same diameter as the rings to be ground. With this kind of a sleeve, the spring of the metal will relieve the rings of all pressure as soon as they have been clamped on the mandrel and the screws in the sleeve-lugs loosened. They will then be in proper condition for grinding.

The Fellows Gear Shaper on Automotive Work

By Eugene Bouton
Chandler Motor Car Co., Cleveland

REFERRING to Mr. Dowd's article on how to estimate gear-cutting costs, as published on page 299, Vol. 61, of the *American Machinist*, the methods used for estimating work on the Fellows gear shaper could not be used to any great extent for accurate costs. Mr. Dowd claims that it is necessary to consider whether the work will be done on the up or down stroke, but this does not have any effect whatever on the time required to cut the gear. The work arbor and its supports, together with the design of the gear, determine which stroke shall be used. For a cluster gear, of course, only the down-stroke can be used, but on some types of plain spur gears it sometimes happens that the up-stroke is preferable to produce a good finish. Theoretically the downward stroke would always be best, because there would be no tendency to lift the blank from the arbor and the thrust would all be taken up by the base of the machine.

Reference is also made to the number of strokes per minute. Mr. Dowd shows 150 to be the maximum, but the Fellows company charts and set-up diagrams specify a countershaft speed to give 200 strokes per minute maximum. It has been observed by the writer that in various shops these machines are belted accordingly. Mr. Dowd does not explain why he uses 216, 286 and 418 strokes per inch of pitch diameter and one who used these figures for estimating would be liable to considerable error. Neither does Mr. Dowd refer to the size of the cutter used—whether it is 3-in. or 4-in. in pitch diameter. He also omitted any reference to the "pitch-gear," the master wheel in the train of the machine, and the one governing the speeds of rotation of the cutter and blank. These factors are very important.

There are estimating methods commonly used for this work which are much more practical. A very simple method for finding the time for one cut around the blank and one which is very close is as follows: Using the factor 1,400 for fine feed, 1,000 for medium feed, or 750 for coarse feed, multiply the proper factor by the number of teeth in the gear. Then divide the product thus obtained by the number of teeth in the cutter times the strokes that the machine makes per minute.

Assuming that we wish to cut a 6-in. gear with 48 teeth, using a cutter with a pitch diameter of 4 in. and 24 teeth, the machine should operate at 200 strokes per minute. Substituting these numerical values, we find that the time to take one cut around the gear is

$$\frac{48 \times 1{,}000}{24 \times 200} = 10.000 \text{ minutes.}$$

If it is desired to take two cuts, the result given is simply multiplied by two.

If the same gear were to be cut with a 3-in. cutter, more time would be required. Cutters 4 in. in diameter can be used on 6-pitch gears and finer at a considerable saving of time, and the gears produced are of the same quality as those made with the 3-in. cutter. The time for one cut with the smaller cutter is

$$\frac{48 \times 1{,}000}{18 \times 200} = 13.33 \text{ minutes.}$$

This formula does not take into consideration the time required to mount and replace the work. In addition, if more than one gear is mounted on an arbor, the time per piece would be the machine time divided by the number of pieces mounted.

The size of the gear determines how many machines one operator can take care of. If the gears are small and only one can be cut at a time, similar to a cluster gear, one operator can handle from two to three machines and the cost of each individual gear is thus divided by the number of machines operated. If the gears are large some operators can handle as high as six machines, and the estimate must be based on as many machines as the operator can take care of and produce quality work. The above formula given is approximate and is close enough for all practical purposes, but if it is desired to make closer calculations the following formulas will be found accurate.

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After the speed and feed of the machine have been decided upon, the next step is to calculate the time in minutes necessary for the cutter to feed in to depth. This is found by means of the formula

$$t = \frac{W}{0.0018 \times S} \qquad (1)$$

in which

t = Time in minutes required to feed in to depth;
W = Whole depth of tooth in gear;
S = Strokes of gear shaper per minute.

The time in minutes for the gear blank to make one complete revolution is determined by another formula

$$T = \frac{s \times D}{S} \qquad (2)$$

in which

T = Time in minutes required for one revolution of the blank;
s = Strokes of machine per inch of pitch diameter of gear being cut;
D = Pitch diameter of gear being cut in inches.

The value of s varies with the fineness of the feed used. A number of values with fine, medium and coarse feed, and with different sizes of cutters, are given below.

Diameter of Cutter in In.	Strokes per In. of Pitch Diameter of Gear Blank Fine Feed	Medium Feed	Coarse Feed
1	1,390	955	721
2	695	477.5	360.5
3	463.3	318.3	240.3
3.5	397.1	272.8	206
4	347.5	238.8	180.2

As an example, let us find, approximately, the time required to cut a cast-iron 6-pitch gear, with a pitch diameter of 8 in. and a 1-in. face, using a 4-in. cutter, the gear shaper operating at 200 strokes per minute. The requirements are that the gear must have smooth and well finished teeth, and be otherwise considered first-class. We have decided on 200 strokes per minute and, in order to be absolutely certain that a fine smooth finish will be obtained, both roughing and finishing cuts will be taken, using the medium feed. Assuming that we can hold three blanks on the work arbor at one setting, we will have a total face width of 3 in., which is about the maximum for cast-iron at the given speed.

Then the time t required to feed in to depth is found by equation (1) to be

$$t = \frac{W}{0.0018 \times S} = \frac{0.375}{0.0018 \times 20} = 1.04 \text{ min.}$$

the time T required to make one complete revolution of the gear blank is determined by formula (2) to be

$$T = \frac{s \times D}{S} = \frac{238.8 \times 8}{200} = 9.55 \text{ min. for one cut,}$$

or 19.1 minutes for two cuts. Therefore, the total cutting time required to complete the three gears is $1.04 + 19.1 = 20.14$ min. and the cutting time for one gear will be 6.71 min., approximately.

We have not, in this calculation, taken into consideration the time required to replace and remove the work, set the machine, etc. As has been previously mentioned, this is dependent upon the size and shape of the work and the type of fixture used. The loading and other idle time for the average run of work varies from one-tenth to one-third of the cutting time. In this case the work is comparatively simple to load, so we will take one-tenth, or 0.67 min. Therefore, the total estimated time per gear is 7.38, or approximately 7¼ minutes.

All the above refers to the No. 6 type of shaper. For the high-speed shaper, the estimating factors are completely changed. This machine operates at from 400 to 800 strokes per minute and is approximately three times as fast as the No. 6 on a single gear. Owing to the speed of this machine, it is not practical to cut more than one gear at a time, unless the faces can be mounted flush with each other and the stroke does not exceed two inches. If the gear faces are separated by the design, or by spacing collars, an intermittent cut would be necessitated and would be too severe for a machine of this kind. For cluster gears and similar work, this type of machine is the faster, but on types of gears where three or four pieces can be mounted, the No. 6 will produce the same amount of work in a shorter time if a 4-in. cutter is used.

For estimating the time to cut gears on the high-speed machine a number of empirical factors have been worked out. These factors are based on practical experience and will give results that are reasonably accurate. The use of the factor can be understood from the following expression for the total time to complete a gear:

$$T = \left(\frac{M}{C} \times G \times N\right) + T_c \qquad (3)$$

in which

M = Empirical factor;
C = Number of teeth in the cutter;
G = Number of teeth in the gear;
N = Number of cuts;
T_c = Changing time.

The values of the factor M are given in the table below. The figures at the bottom of each column represent the strokes per inch of pitch circumference, 510 being a very coarse feed and 1,620 a very fine feed.

Strokes per Min.	Factors (M)						
400	1.275	1.950	2.232	2.270	2.905	3.545	4.000
450	1.135	1.733	1.980	2.417	2.582	3.152	3.600
500	1.020	1.650	1.786	2.176	2.324	2.936	3.240
550	0.927	1.419	1.623	1.976	2.112	2.579	2.945
600	0.950	1.300	1.488	1.813	1.936	2.363	2.700
650	0.784	1.200	1.373	1.673	1.787	2.181	2.492
700	0.728	1.114	1.275	1.554	1.660	2.026	2.314
750	0.680	1.040	1.197	1.450	1.549	1.890	2.160
800	0.637	0.975	1.116	1.360	1.245	1.772	2.025
Feed gears	84–38	72–50	68–54	62–60	60–72	54–68	50–72
Strokes per in. pitch circum.	510	780	893	1,088	1,162	1,418	1,620

As an example of a calculation of the time for a job on the high-speed shaper, let us assume that a 10-pitch gear with 90 teeth is required, the finish necessitating two cuts with the 1,088 feed. A cutter with 30 teeth is to be used, the machine operating at 700 strokes per minute.

The factor M is found from the table to be 1.554 and the substitution of the other numerical values in equation (3) gives

$$T = \left(\frac{1.554}{30} \times 90 \times 2\right) + 0.75 = 10.074 \text{ minutes.}$$

Due to an automatic feature of the high-speed shaper, which stops the machine after the completion of the work, it is sometimes possible for an operator to handle one more machine in a group than can be cared for when No. 6 machines are used. This should be taken into consideration when estimating the costs.

AUTOMOTIVE PRODUCTION

Abstracts

from other publications

Maintaining High Quality Production

In the discussion of this problem at the S.A.E. meeting, K. H. Herrmann, of the Studebaker Corp., stated that in its automatic department it has screw thread inspectors who visit each of the automatic machines at regular intervals to inspect the product. If conditions are not satisfactory the inspector can order a shut down until they are corrected. The ground taps now used, although higher in first cost, are cheaper in the long run.

Mr. Herrmann also remarked that if all the parts that go into scrap were taken together, one complete car could be built out of every three hundred, and as the Detroit plant builds three hundred cars per day, the value of the material scrapped in a day amounts to the cost of a complete car. There should be no salvage limits. Parts should be according to drawings. It is cheaper to scrap a part in the first place than to send it through in salvage lots or to take chances. The production superintendent and the foremen are very careful because a record is kept of each department's scrap and at the end of the month or year the amount of excess scrap may be considerably more than the amount of the salary of the foreman of a department; that alone provides food for thought.

Mr. Frauenthal, of the Chandler Motor Car Co., stated that in engine and chassis assembly, as well as in other departments, the company has a group-piece-work arrangement. If the final inspector rejects a finished unit because of an error somewhere near the beginning of the line, the entire assembly must be torn down and rebuilt and the men in the group must suffer for it. This usually results in causing each man to observe carefully the work of the man just ahead of him and it acts as a good disciplinary measure.—*S.A.E. Journal*, November, p. 438.

The Machine Tool Builder in the Automotive Industry

The article considers mostly the question of machine tools in the automobile plant and the cost of maintenance of machine tools as one of the heavy items of expense because the service demanded is so strenuous. In one of the large plants maintenance cost averages annually 10 per cent of the first cost of the equipment and expressed in definite figures runs from $30,000 to $40,000 a month in a plant employing 7,000 men. One of the principle sources of trouble is due to the use of cast-iron bearings. Ball or roller bearings are advocated for use in their place. Another engineer advocates hardened steel ways for all horizontal sliding bearings that are exposed to cooling compounds. This applies to gear cutting machines lathes and turning machines of all kinds where a carriage slides back and forth and where chips fall on ways exposed to cooling compounds.

It is recommended that a complete study should be made of the methods and production problems encountered in the shops. In this difficulty neither the salesman nor the manufacturer of machine tools can have a thorough appreciation of what the high production pressure of the automobile plant really means. If a machine tool manufacturer is called upon to make production estimates he must always consider the variations in materials that are likely to be met with in the shop and an assumption in these has often lead to considerable embarrassment and even loss. One production manager of a large truck corporation stated that "The weakest spot in the manufacturing practice of the automobile industry is uneven production." Another engineer stated that one weak spot was the tendency to work to wider limits in order to increase production, thus causing a reduction of quality. Another engineer states that he considers the weakest spot in automotive practice to be the inspection systems. Most of these find out that a piece is wrong after a great quantity of wrong pieces have been made.—*Machinery*, November, p. 179.

Aërial Engineering

Grover Loening gives a detailed description of how the engineer goes about laying out an aëroplane. He first demonstrates that it should carry a ton of load about 100 miles per hour. He refers to the assembled data on well over 500 different sections of wing surfaces in which the lifting power and the resistance are tabulated minutely in elaborate tables. There are also thousands of measurements of the head resistance of various parts of a machine. He shapes the body of his plane accordingly and uses the most appropriate wing section to formulate a preliminary design. He then makes a model of the proposed plane to a scale of $\frac{1}{12}$ in. of full size to great accuracy and places it in a wind tunnel. Air traveling at 40 to 50 miles per hour is blown on the model and the model being suspended in this air-flow by fine steel wires attached to the most delicate balances is actually flying, but flying under control and command of an engineer who is carefully measuring the lifting power and resistance through a large range of angles. It is amazing to find that this little wind tunnel model is a perfect fore-runner of actual conditions. From these tests the engineer starts off with a vast amount of technical data on the details of beams and struts and fittings and the stresses in members, etc., an assembly of data that is just as impressive, accurate, and complete as the engineers of the American Bridge Co. have for their bridges.

The use of light structure material has been developed to a high degree. Balsa wood for example is found to be the strongest structural material known. It is a light wood, largely pith, weighing only 8 lb. per cu.ft., and one-third the weight of the lightest pine wood ordinarily seen, but it is so soft that we have had to learn a great deal about how to take hold of it, and curiously, where duralumin fittings are fine for taking hold of the harder woods, we find that hard wood is the best thing with which to take hold of balsa.—*Aviation*, Nov. 3, p. 1224.

Safety Couplings for Machine Drives

By F. Osgood Hickling
Newark-on-Trent, England

Devices to prevent damage to machines when drives or feeds are overloaded, and which take the place of the "breaking pin" in light machines

IN MANY classes of small machines, especially those that are automatic in their action and do not demand the constant attention of an operator, it is highly desirable to incorporate somewhere in the driving or feeding mechanism a device that will automatically become disengaged in case of accident to the tools or any incident that may interfere with the normal movements of the machine and impose upon the parts a strain greater than they are calculated to withstand.

The illustrations herewith show various devices that have been used successfully for this purpose, and that have justified the slight additional cost of making and installing them by preventing damage to delicate parts, the repair or replacement of which would involve a many times greater expense.

One of the simplest of these devices, shown in Fig. 1, is applicable to the feed drive of many small machines. The feed shaft is made in two parts, abutting at *A*, and the break is covered by the hardened steel sleeve *B*, which is free to slide endwise for a short distance upon its shaft but prevented from rotation with reference thereto by the hardened pin, *C*, driven crosswise through the shaft and extending into elongated holes, or slots, on each side of the sleeve. A similar pin, *D*, in the other part of the shaft, rests in a generous V-groove that is cut across the end of the sleeve, which groove is held firmly in engagement with the pin by the action of the compression spring *E* between the sleeve and a fixed collar upon the shaft.

Either end of the shaft may be the driving member. It is obvious that so long as the load upon the driven member does not exceed a predetermined amount, adjustable by increasing or diminishing the resistance imposed by the spring, the device will revolve as a unit; but as soon as the strain becomes excessive, the sleeve will recede against the action of the spring and allow the driving member to rotate while the driven member remains idle.

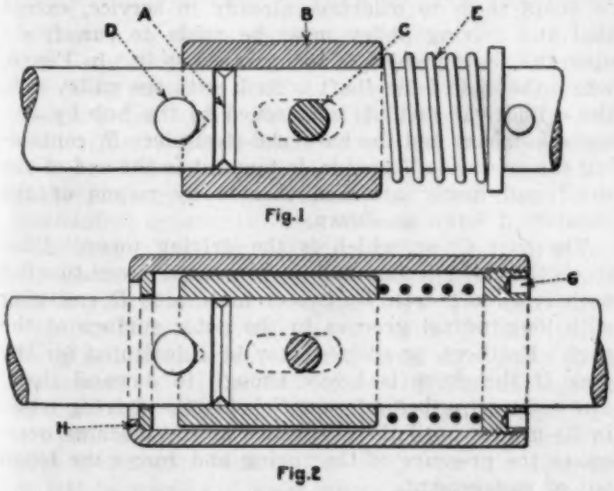


Fig. 1—Safety coupling for feed shafts. Fig. 2—Self-contained and balanced coupling

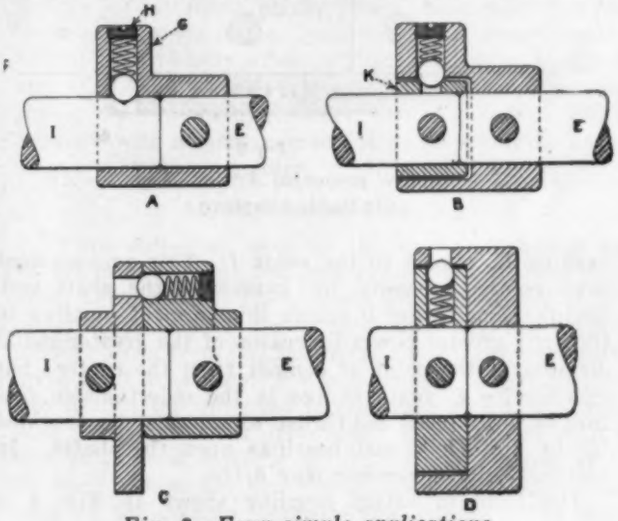


Fig. 3—Four simple applications

A disadvantage possessed by this device is overcome by the slightly more expensive arrangement shown in Fig. 2, which is identical in principle. In the first instance the pressure of the spring is exerted to force the shafts apart endwise, and as this pressure is exerted equally in both directions it must be sustained by suitable collars and thrust-washers upon both shafts. As arranged in Fig. 2 the device is entirely self-contained and there is no end thrust upon the shafts.

In this case the active parts remain the same as before, but the entire device is enclosed by a sleeve screwed to the fixed collar *G*, and at the other end engages a similar, though smaller, collar, *H*, upon the other shaft. The pressure of the spring is thus sustained by the sleeve, which is under tension, and no end thrust is exerted upon the shafts.

In Fig. 3 may be seen four forms of a safety coupling that is even more simple than those previously illustrated. At *A* there is pinned to the member *E*, a sleeve having upon one side a radial projection *G* in which is a chamber to enclose a hardened steel ball and a coil spring, both held in place by the small headless screw *H* in the outer end of the chamber. The member

I turns freely in the open end of the sleeve but is held in relation to member *E* by the ball, which under pressure of the spring engages a "dimple" in the shaft made by sinking in the point of a twist drill. The end of the shaft, back to and surrounding the drill-spot, should be hardened.

At *B*, the end of the shaft *I* is covered by the steel

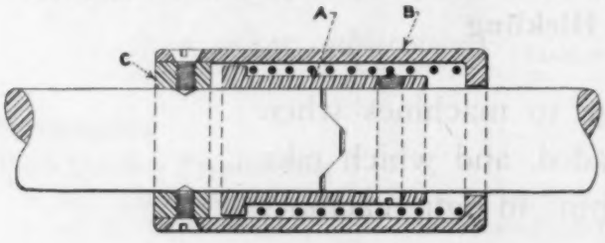


Fig. 4

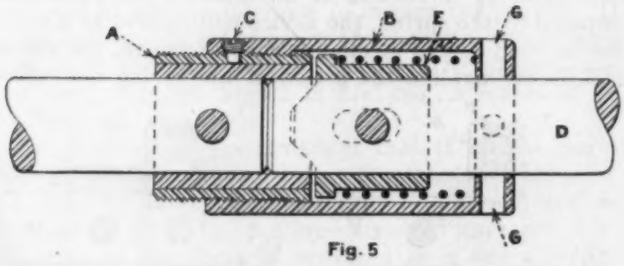


Fig. 5

Fig. 4—A more powerful drive. Fig. 5—An adjustable coupling

bushing *K*, pinned to the shaft *I*. This arrangement obviates the necessity for hardening the shaft end. Modifications *C* and *D* enable this form of coupling to transmit greater power by reason of the greater radial distance of the point of contact from the center; but modification *C* again brings in the objectionable feature of unbalanced end-thrust which must be provided for by suitable thrust bearings upon the shafts. In each case either member may drive.

The form of safety coupling shown in Fig. 4 is

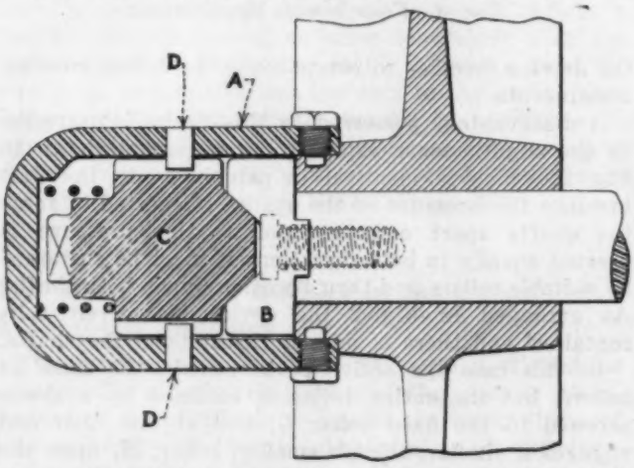


Fig. 6—Coupling for main drive—pulley on end of shaft

capable of transmitting somewhat greater power than the foregoing types, in proportion to the space occupied by it. In this arrangement a V-groove is made across the end of one member to engage with a corresponding tenon on the end of the other member. The shouldered bushing *A* is pinned to one member, while the enclosing sleeve *B* is attached by small countersunk head screws to the collar *C*, which is fixed to the other member by pinning, or, as shown in the sketch, by allowing the attaching screws to pass through it and enter drilled spots on the shaft. This type of coupling is also self-contained and without end thrust, but to allow it to disengage, one or other of the members must be free to move endwise. As before, either member may drive.

A modification of Fig. 4 is shown in Fig. 5, in which an externally threaded collar *A* is pinned to one member and the enclosing sleeve *B* screwed upon it, being held from turning by the grub-screw *C*, the point of which enters a longitudinal groove upon the outer surface of the threaded collar *A*, which must be removed in order to turn the sleeve. The sleeve *B* is a free fit upon the member *D* but is not attached to it. Pin-holes *G* in the sleeve *B* provide for the use of a pin to turn the sleeve (after the screw *C* is withdrawn) for the purpose of adjusting the pressure of the spring.

The shouldered bushing *E* slides upon the shaft *D* and is held against rotation by a cross-pin in the shaft extending into longitudinal slots in the bushing, as in Figs. 1 and 2. The advantages of this arrangement are that not only is the entire mechanism enclosed and there is no end-thrust upon the shaft members, but the spring pressure may be adjusted to supply more or less power to the drive by merely screwing the sleeve *B* in or out upon its threaded collar.

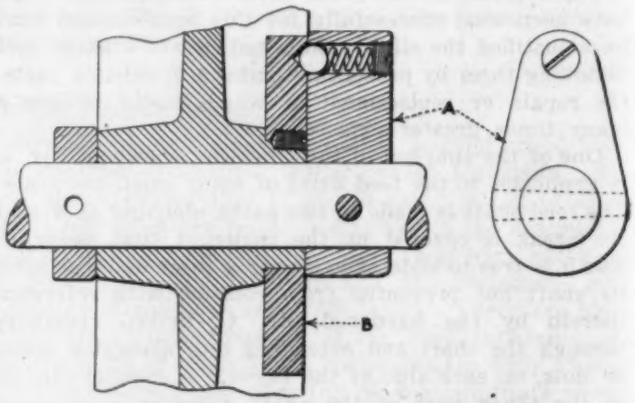


Fig. 7—Coupling for main drive—pulley mid-way of shaft

In Figs. 6 and 7 are shown adaptations of both principles to the driving shafts of the machine. No exchange of existing conditions need be made in order to adapt them to machines already in service, except that the driving pulley must be made to run freely upon the shaft instead of being keyed to it. In Fig. 6, where the end of the shaft is flush with the pulley hub, the cylindrical shell *A* is attached to the hub by any suitable means and the hardened-steel piece *B*, containing the crosswise V-groove, is tenoned to the end of the shaft and firmly attached thereto by means of the shouldered screw as shown.

The part *C*, on which is the driving tenon, slides freely in the cylinder and is prevented from turning with relation thereto by two or more pins *D* engaging with longitudinal grooves in the outer surface of the part. Feathers, or splines, may be substituted for the pins if the drive is heavy enough to demand them. The coil spring behind part *C* holds the driving tenon in its groove until the resistance of the machine overcomes the pressure of the spring and forces the tenon out of engagement.

If the pulley is not on the end of the shaft a modification of the ball drive, as shown in Fig. 7, may be

adapted. The arm *A*, in the end of which is a chamber for the spring-loaded ball, is pinned to the shaft and a hardened steel disk *B*, having the "dimple" near its outer edge to correspond with the position of the ball, is attached to the hub of the pulley. The greater the radial distance of the ball from the shaft center, the greater will be the power of the drive.

A feature of all these devices that may strike the reader unfavorably is that when the secondary or driven member is stalled from sudden overload, the driving ball or tenon will re-engage at each revolution or half-revolution of the mechanism as the case may be. It can be said from experience, however, that if the parts have been generously proportioned there need be no evil effect, except the noise that will ensue, and even this is of distinct value since it constitutes a warning of trouble that the operator can neither mistake nor disregard.

Museum or Machine Shop?

By F. M. A'Hearn

THE wheels of the Dick Pump Works were first set in motion by John Dick, Sr., back in the sixties. Old John, then a youngster (so says tradition), had been working as a machinist in one of the neighboring towns, and seeing a growing town without a machine shop, an opportunity, and the only girl, had taken all three and located in Woodland.

The start was made without the assistance of the Chamber of Commerce and was not even mentioned at the weekly meeting of the Kawampus Club. John's equipment consisted of a ratchet, a vise, a few discarded taps, some home-made drills, a screw plate, a few flue rolls, and a ball peen hammer, for be it known that the machinist of that period could set flues or patch a boiler as readily as he could cut a thread with a hand chaser. John was out for anything that looked like business. He found plenty.

The neighboring coal mines provided their share and in a few years John had a prosperous business and decided on a side line to keep the hands going during the slack periods of repair work.

The Dick steam pump was a success from the start and gradually became the mainstay of the business. The sign on the shop roof was painted over, the words John Dick Machine Shop giving way to the more attractive title, "The Dick Pump Works."

John rounded out a useful career, became a member of the town council, ran things generally in his lodge, and finally passed out leaving the ownership of the plant in his family and under the management of John, Jr., the oldest son.

A Visit to the Old Shop

Happening to be in Woodland one day I dropped into John's office in time to meet two of his old cronies, Jim Kelly and Bill Weston. All three had served their time together under old John, Kelly and Weston leaving soon after their time was completed. After a period of years Kelly had become a member of a machinery sales company, while Weston was high man in the mechanical department of a railroad.

Although Kelly and Weston had come to Woodland especially to spend a week with old friends, Kelly could not refrain from describing some new tools his company was handling, he feeling justly proud of his line as being second to none. John listened attentively to the statements of Kelly and examined the photographs handed him, returning them with the comment that the tools might be all right for Weston in his railroad shop, but as for himself, his shop was well equipped, in fact he would not know where to find room to place another machine.

Weston suggested that we walk out into the shop as he would like to look the old place over. The shop was like a mechanical review showing the progress of the machine tool builders' art from or before the time of the Civil War, and with a few exceptions, terminating with the recent Spanish-American misunderstanding. Replying to a comment being made as to who was the builder of a small planer, John remarked that he believed that his father had purchased that machine second-hand shortly after he had started in business, and that "she wasn't in bad shape yet." True, the planer was in running order, but for output would compare with a modern machine as favorably as an ox team would with a tractor.

A Combination Machine

Weston called me over by the wall and showed me an old machine that was new to me; a combined drill press and slotter. The column was artistically fluted and designed more for beauty than rigidity, rising proudly alone from the base plate toward the horizontal drive shaft at the top. No back bracing to that column. No, sir. It was intended to take care of its own business. The horizontal drive shaft was provided with a disk at the end opposite the drill spindle gears, while the ram guides for the slotter were mounted on the back of the column, opposite the spindle. The drill spindle was fed by the reliable old horizontal hand-wheel revolving around the spindle. The power feed had been omitted by the builder.

One table served either side of the combination as the table arm could swing from a position beneath the drill spindle to the neighboring slotter or the reverse. The table was provided with a circular hand-operated feed and was the usual compound slotter table.

After we have viewed this interesting specimen we stepped over to where Dick and Kelly stood discussing the planer. Kelly, giving his opinion in the stock phrase of a few well chosen words, said, "Lookit here, Dick. You call that a planer. It's not. It's a combination of an antique and a robber. I admit that it has historical and sentimental value, but as a machine tool she steals you blind, costs the same rate per hour for that machinist, and occupies as much floor space as a real machine. That combination drill and slotter and a few more of these veterans are past due for retirement and are breeding a case of dry rot in your business."

As Bill Weston was a neutral party, Dick and Kelly seemed inclined to allow him to arbitrate. Thus solicited Bill gave his views as follows:

"Our management sells or scraps small locomotives frequently. Why? Obsolete covers the whole thing. To be sure they have a coupler on each end, will run

as fast as the big ones, and will move cars according to their capacity, but they were designed to suit conditions twenty-five years ago.

"The locomotives were built when cars were small and built of wood. These machine tools were designed when cuts were small and high-speed steel unknown. Probably the cutting speed of that planer can be made as high as a modern one, or you can belt that drill to give as many r.p.ms. as you wish, but in either case there is nothing back of the speed in the way of power and no body for heavy cutting.

"If you look back, Dick, you will see that many small plants, and some good sized ones, that were prosperous when your father was building this business have passed out. Why? Not because they moved backward, but because they did not move forward.

KEEP UP-TO-DATE OR FAIL

"You remember Hampken Sons and Co.? Built saw mills. Had a good trade, too, but the timber finally gave out and as they were not known outside their own district the business fell off. Well, Sam and Jim sat around waiting for something to turn up. It did in the form of a sheriff's sale. Billy Hicks, who left their foundry a few years before to make window weights on a small scale, bought out the remains of H. S. & Co. and junked most of it. Billy did not stick to window weights or sled shoes alone—he hustled for business, got it, and is still going strong. Your father did not stand still. He kept adding the best tools he could afford as his business grew. I remember his steam pumps, later the motor-driven geared plungers he designed, and you know that before he retired he looked forward to the centrifugal types succeeding the plungers.

"You made that dream come true, but you cannot afford to stop now. The coal in this district will pinch out sooner or later, and you will be up against stronger competition than you have now. It would seem to be a wise policy to use as much business method in a shop as on a chicken farm. You know a poultry raiser sees to it that every hen does her bit, or off goes her head. My opinion is that some of these old tools are mighty poor layers.

"You remember reading Chordal's Letters when we were working for John, Sr. You remember what he said about Wycoff's shop and how he compared our ideals in a republic with the old country ways. What he said then is true today. We are nationally progressive and ever moving. The old country nations are not like us. Therefore, a shop can drag along for generations among them, but that is not the U. S. A. way. You must move with the parade or you will soon lose sight of it."

After Kelly and Weston had bid John good-bye I could see that what Weston had said was causing John to do some serious thinking when he remarked that Weston was a mighty successful man, otherwise he could not hold down his job, and in addition to that, Weston was the guiding spirit in a manufacturing plant that was paying dividends and laying up a surplus.

I was in Dick's shop a few weeks ago. He has replaced a lot of his relics with some good machine tools, and is putting out a line of contractors' machinery that is in demand for the state highway work that is under construction. The new tools have made Dick ashamed of their surroundings for he has cleaned and brightened the place up wonderfully. The output of these machines seems to have had an influence in speeding up the whole works for there is a snap to things that was missing before. Dick is waxing fat and sassy and tells me that Bill Weston knows a thing or two aside from motive power and cars and that the Dick Pump Works will continue for some time to come in its proper place close to the band wagon.

Famous Machinists of History

BY H. H. MANCHESTER

Oliver Evans (1755-1819)

Oliver Evans was born at Newport, Del., and as a boy was apprenticed to a wheelwright, where he learned to run a lathe, a drill, and the other tools used in the business.

When scarcely 22 years old he invented a machine for making card teeth, which were used in carding wool.

In 1779 he entered business with his brothers, who were millers, and not long afterwards developed the system of the automatic handling of materials for mills, for which he invented or improved the elevator, conveyor, drill, hopper boy, and descender, as he called his devices. In 1786 and 1787 he obtained the exclusive rights from Maryland and Pennsylvania to use his improvements in flouring mills. These were very successful, and inaugurated a distinct epoch in milling.

Late in the century he established a machine shop in Philadelphia. In 1802 he built a steam engine which he applied to grinding plaster of paris and sawing wood. His engine was built on the high pressure principle, and, finding it was different from Watt's, he took out a patent for it. Thus he is one of the first originators of the modern type of steam engine.

In 1804 he built a steam dredge for the Philadelphia board of health. In order to demonstrate the possibilities of his engine, he placed this scow, which he called the "Oracter Amphibolos," or "Amphibious Digger," on wheels and ran it around the square and then down to the Schuylkill, a distance of 1½ miles. There he fitted a paddle wheel to the stern, and steamed the barge up the river to its juncture with the Delaware.

His "Miller and Millwright's Guide" went through a score of editions, and his "Young Engineer's Guide," published in 1805, was translated into various languages.

Evans died in New York City in 1819. He was a man of great originality, and highly practical. In fact he was so practical that he refused to take the time to develop his own inventions if he could not see that they were in immediate demand.

Ruling Line Standards

By Herbert P. Lewis[1] and C. G. Peters[2]

A method of producing line standards free from measurable error by the application of light interference and the end-measuring machine upon which they are used

IN MAKING accurate measurements of plug gages of the cylindrical, square, or taper type, spherical balls, end gages, disks, etc., some kind of end-measuring machine must be used. The length measured by the machine must be taken from a calibrated screw, precision end gages, or a line standard. The screw type of machine is subject to quite large errors in the screw itself, while the slow motion and mechanical difficulties make it impractical over any great range. While a machine where the contact surfaces are set with precision gages can be made to give very accurate results and is very well adapted to measuring a large number of pieces of the same size, it is open to the objections of requiring a large number of gages if a large range is desired, and to being slow of adjustment for intermediate sizes. The larger range, together with the easy manipulation and high accuracy of the end measuring machine—which depends upon the line standard for the length measurement—led the Brown and Sharpe Manufacturing Co. to adopt this type of machine for use in its Small Tools Department and to furnish the standard for the plant.

These machines are required to measure objects that differ in size from a fraction of an inch to six or seven inches and to change from one size to another easily and quickly. Fig. 1 will give some idea of the variety of pieces that have to be measured. Since the measurements must be correct within a very few hundredths of a thousandth of an inch, the machine must be extremely rigid, the measuring head sensitive, and the line standard free from measurable errors. The machine shown in Figs. 2, 3, 4 and 7 fulfills these requirements very satisfactorily. There is shown in Fig. 2 a general view of one of these machines presented to show the base, which is a cast-iron box section 16 in. deep with side walls 1 in. thick, giving the effect of two I-beams placed side by side. The top surfaces and the edges at the top are scraped to furnish a support and guide for those parts in which the measuring elements are contained. The sliding element on the right contains a 40-pitch measuring screw, upon one end of which a wheel is mounted having 250 graduations upon its rim. This makes each interval on the wheel rim indicate a change in position of the measuring point of 0.0001 in. along the axis of the machine. The fifth decimal place is indicated by a vernier plate, mounted to overlap the edge of the wheel, over which a low-power magnifying glass is mounted to facilitate reading. The measuring point of this element is on the opposite end of the screw from the wheel, and may be seen protruding from the left side of the support. Traverse of this measuring-screw supporting member is obtained through the screw and handwheel shown.

No Dependence Upon Screw

The elimination of dependence upon a screw for the accuracy of a measurement is practically accomplished by subdividing the first inch interval of the line standard into forty intervals, which makes it necessary to use but half a revolution of the screw as a maximum. This half-turn gives linear values which are accurate within 0.00001 inch.

The element on the left, which is traversed and locked in the same manner as that on the right, carries a sliding bar, upon the right end of which the

[1]Brown & Sharpe Mfg. Co., Providence, R. I.
[2]Bureau of Standards, Washington, D. C.
Presented at the Annual Meeting, New York, December 1 to 4, 1924, of The American Society of Mechanical Engineers.

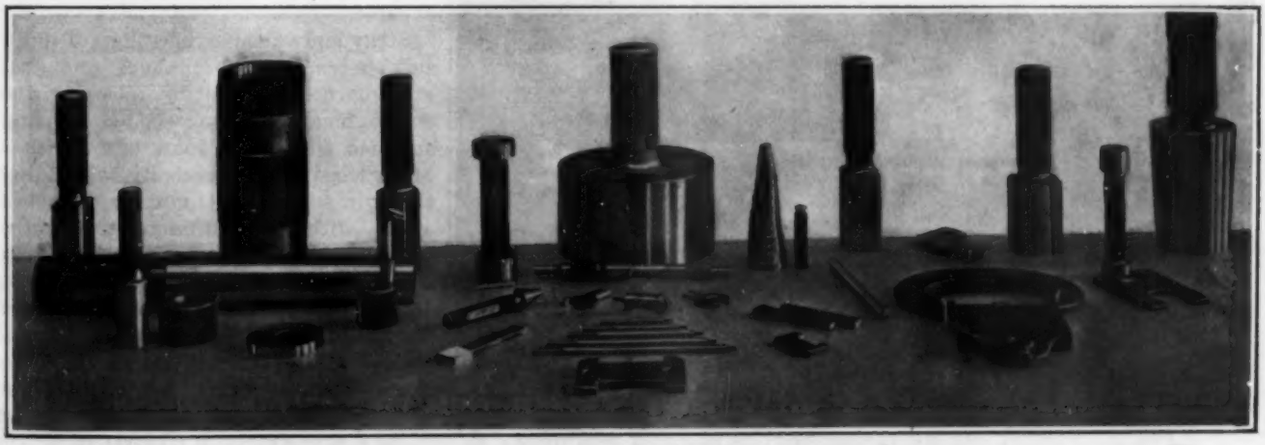


Fig. 1—Variety of pieces requiring accurate measurement

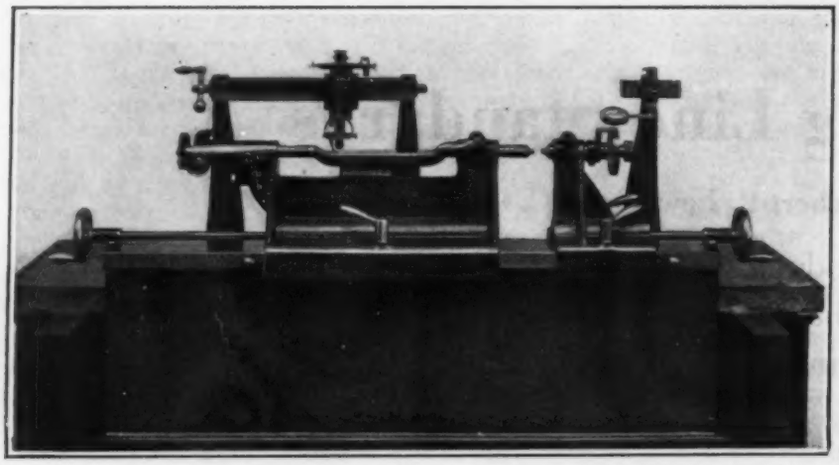


Fig. 2—General view of end measuring machine

measuring point is mounted. The purpose of these traversing mechanisms is to prevent fleeting in making longer settings than 7 in., but this is not done frequently since measuring machines containing bars 40 in. in length are used on larger work. The end of the sliding bar opposite the measuring point is supplied with two knurled wheels for the lateral adjustment of the bar in setting. The wheel lying in the plane of the cut is for quick adjustment, while the wheel in a plane 90 deg. to it is a slow-motion screw. The handle shown near the measuring point is used for locking the bar in place after a setting is made, while the one at the opposite end is for throwing in the slow-motion screw. The central portion of the sliding bar is cut down to the center line for some distance, and so machined that when the line standard is mounted the plane of the surfaces upon which the lines are cut contains the axis of the measuring points while the lines lie along this axis. The body of the line standard is smaller than the cavity in the sliding bar in which it is carried, offering an opportunity for aligning it properly with the axis of the measuring points. When properly aligned, plaster of paris is filled in around the standard giving it a permanent setting. This may be seen in Figs. 3 and 4.

The mounting of the microscope unit and the line standard is best shown in Fig. 4. Above the line standard an 80-power microscope is mounted to traverse, by means of the screw shown, along a beam the surfaces of which are scraped and which is aligned with the axis of the measuring points. This beam is supported at each end by a heavily webbed member resting on the base of the machine. A small electric lamp is suspended from the microscope carriage and is operated through a foot switch on the floor at the front of the machine. The light from this source enters a 90-deg. reflecting prism in the microscope and is reflected to the surface of the line standard, furnishing the illumination for setting. By this arrangement the light source is always in the same relative position to the microscope and there is no danger of expansion due to the heating of the lamp since the lamp is burned only during the setting, which is a very short period of time.

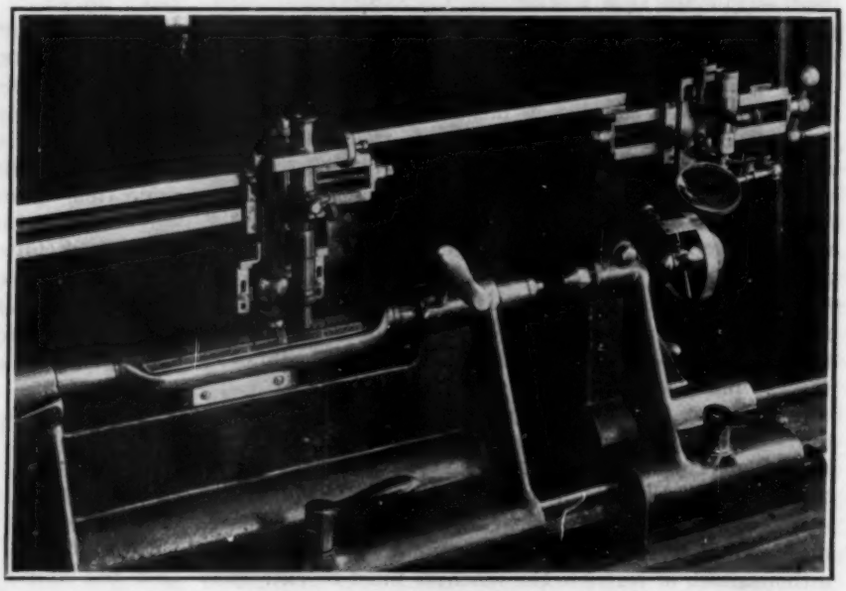


Fig. 4—Enlarged view of machine shown in Fig. 3

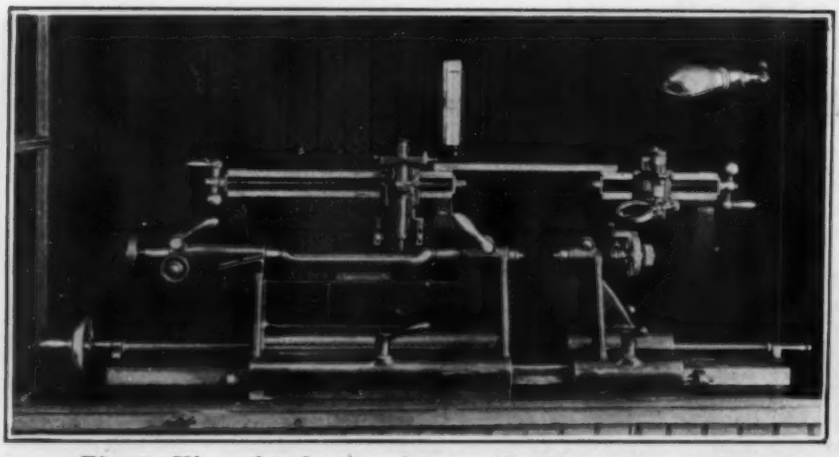


Fig. 3—View of end measuring machine showing mounting of microscope unit and line standard

Stray and variable reflections of light, sudden temperature changes, and dust are guarded against by inclosing the entire machine in a wooden housing supplied with glass doors and a means of ventilating the base. By suspending the light source in the manner described above, with its position relative to the microscope constant, and by painting the inside of the housing a dull black, the danger of errors resulting from variable illumination of the line standard is eliminated. When all the foregoing precautions are taken, the error of setting on a well-ruled line is found to be not in excess of 0.00001 inch.

In order to keep the accuracy com-

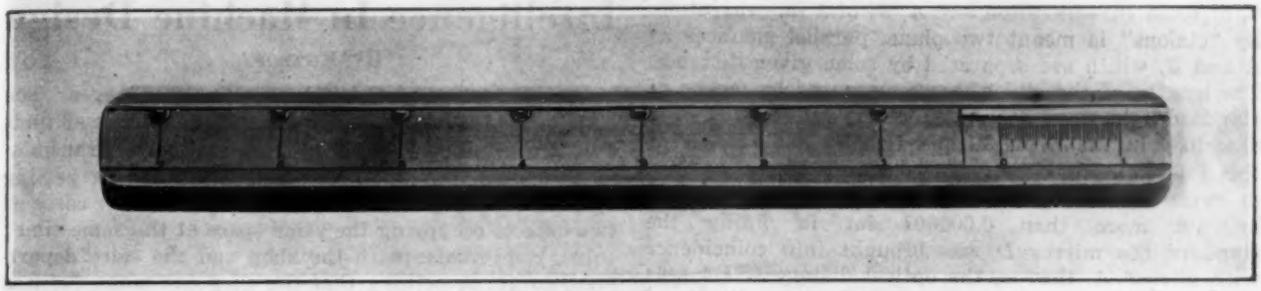


Fig. 5—A line standard with stellite inserts

parable with the remainder of the machine, a line standard was required having errors in any interval so small that they could not be detected by a micrometer microscope. To meet the requirements a line standard had to be produced from very permanent material, the lines had to be straight-edged within 0.000001 in., and the distance between any two lines had to be correct to less than 0.00001 in. To meet the first of these requirement, the line standard shown in Fig. 5 was made of machinery steel which was annealed before, during, and after machining. In machining, equal amounts of stock were removed from all sides in order to get well under the scale. All machining was done with light cuts, while each annealing extended over two days. More care than was actually necessary may have been taken during these operations, but the effect of the extra precautions was not detrimental. Inserts of stellite 0.125 in. in diameter were placed 1 in. apart after the first 1-in. interval, and contain lines which divide the standard into 1-in. intervals. At the first inch a stellite plug was inserted parallel to the axis of the standard to furnish a surface upon which to subdivide this inch into forty intervals of 0.025 in. each. The plugs were inserted after all machining had been completed, with the exception of the finish grinding. The blanks were then ground until the top and bottom surfaces were fairly flat, when the finder scale was graduated below the inserts. After applying a substantial plating of nickel, the top and bottom surfaces of the blanks were ground as flat and parallel as possible, and the surfaces of the inserts were lapped. The lapping was done with carefully ground cast iron and with lead blocks, using a mixture of rouge and distilled water. When finished the surfaces were all optically flat within 0.00001 in., and free from any visible imperfections under an

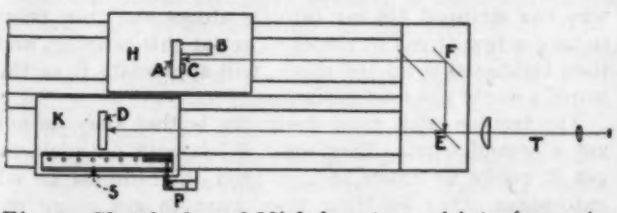


Fig. 6—Sketch plan of Michelson type of interferometer

eighty-power microscope. For several months the blanks were allowed to stand in a place where they would be subject to temperature changes and allowed to age. Observations were made from time to time to determine any dimensional changes or change in the surfaces, but none could be found. All of the desirable characteristics of a commercial line standard are present in these blanks, in that they are made of a material having practically the same coefficient of expansion as the work to be measured, the chances of any dimensional changes occurring is remote, and the surfaces upon which the lines are cut are hard, optically flat, highly polished and are non-corrosive under the most severe conditions, while they take a fine line with clean-cut edges.

Twelve of these blanks were made, and during the

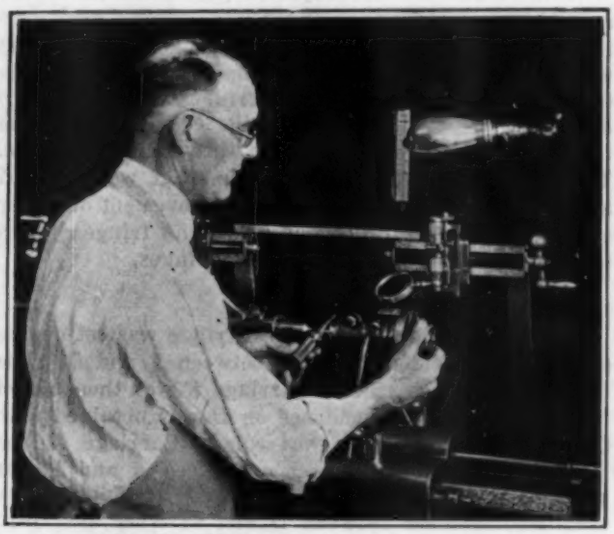


Fig. 7—The machine in use measuring a cylindrical plug gage

time that they were undergoing the above-mentioned process of seasoning the method by which the lines were to be ruled was determined. In order to reach the high degree of accuracy desired in placing the lines on the standard, microscopic methods or methods involving a calibrated screw were eliminated, since any errors that might exist must be so small that they could not be determined with a microscope. This left but one choice, namely, that of some application of the interference of light. Experimental work of this nature was accordingly undertaken, which demonstrated the feasibility of this method. The matter was then taken up with the Bureau of Standards, and it was decided that the Michelson type of interferometer, a line sketch of which is given in Fig. 6, could be used. The blanks were then lined at the Bureau of Standards.

Referring to Fig. 6, the blank standard *S*, together with one plane mirror *D*, were supported on carriage *K* of the machine. A lining mechanism *P* carrying a diamond point was mounted over the blank. By carefully selecting and mounting the diamond it was possible to rule lines 1 micron (0.00004 in.) in width, the edges of which appeared straight and sharp under 1,000 magnifications.

The other carriage, *H*, supported the two etalons *A*,

C, of 0.025 in. separation and *A*, *B*, of 1 in. separation. By "etalons" is meant two plane, parallel surfaces as *A* and *B*, which are separated by some given distance. The lengths of the etalons were measured by means of standard light waves, the method employed having been described in the Sept. 30 and Oct. 7, 1920, issues of the *American Machinist*. The 0.025-in. etalon was not in error by more than 0.0000002 in. and the 1-in. by not more than 0.000001 in. In lining the standard the mirror *D* was brought into coincidence with mirror *A*, that is, the optical distance *EFA* was made equal in length to *ED*. This condition of coincidence could be made within 0.0000002 in. by means of the interference of light waves. The white light from an incandescent lamp mounted beside the telescope *T* was made parallel by the objective of the telescope. On reaching the half silvered mirror *E*, half of the light was transmitted to the mirror *D* while the other half was reflected to *F* and then to *A*. Mirrors *A* and *D* were adjusted perpendicular to the axis of the telescope so the light was reflected back over the same path into the telescope. When *A* coincided with *D*, and the telescope was properly adjusted, a system of white light-interference fringes was brought to a focus in the same plane as the cross-hairs of the telescope, and these were viewed through the eyepiece. The central fringes on either side of it were colored and had a spacing of about ¼ in. A movement of either carriage of 0.00001 in. would cause the fringe system to move the distance between two fringes.

Ruling

When the center of the central fringe was set on the cross-hair, coincidence existed between *A* and *D*. The first line was then ruled. Carriage *K* was then moved to the right until coincidence on *D* was obtained with *C*, when the second line was ruled. Carriage *K* was left stationary and coincidence between *A* and *D* was obtained, when *K* was again moved to the right to obtain coincidence between *D* and *C*, when the third line was ruled. This process was repeated forty times which subdivided the first inch into 0.025-in. intervals. *H* was then moved to the left until *B* was in coincidence with *D*, then *K* was moved to the left until *D* was in coincidence with *A*. This moved the standard back by a single step of 1 in., when another line was ruled into the first line. The offset of these two lines was not more than one-tenth the width of the lines or not more than 0.000004 in., which proved that the error in any subdivision of the inch was not more than that amount. The carriages were then moved to the right by steps of 1 in. and lines 1 in. apart ruled on the round stellite plugs. During this process the interferometer was protected against rapid temperature change and vibration. The light source was at some distance, while suitable apparatus was constructed so that it was not necessary to approach the instrument very closely.

In this way line standards have been produced which are free from errors that can be detected with micrometer microscopes, and which can be used in the measuring machine without the inconvenience of applying a calibration correction for the different intervals.

To sum up, the authors have produced a line standard free from measurable error upon which a micrometer-microscope setting may be made within 0.00001 in. to be used on a measuring machine, well designed and extremely rigid, supplied with a measuring head sensitive to 0.00001 inch.

Intelligence In Machine Design

By Entropy

MOST designs go through at least three stages: The first that of invention, in which the designer finds a way to get the necessary motions and power transmission; second, reduction to possibility, such as getting shafts out from between arms of gears, or other cases of two objects occupying the same space at the same time; third, compromise with the shop and the sales department to get something that the shop can make for less than the sales department can get for it.

The first is the most spectacular, the most interesting, and the last is the most soul-wearying, and gets the least thanks. Yet on the last depends the profits and the existence of the firm.

We often hear the statement, "the drafting room is trying to see how expensive they can make the machine." And how nearly true it is in too many cases. Nine times out of ten the trouble lies in the fact that the shop men and the office men do not speak the same language and cannot make each other understand. The shop man sees each individual piece as a problem in production, and then he sees the job of assembling all the parts, perhaps first as units and then as a complete assembly. The draftsman sees the machine as a whole, that he disassembles into the details he draws, each one with a sigh of relief, because that is his drudgery.

Choosing the Material

The last thing the draftsman does is to decide the material of which to make each part, and by that time he is too tired and sick of the whole thing to give much attention to it. The shop man has to begin by ordering the castings, forgings and bar stock from which the parts are to be machined. He is full of interest right then, because if the part is of cast iron, he wants to be sure that it is heavy enough, not merely to stand the stresses in the finished machine, but that it is stiff enough to stand up under rapid machining.

Then there are a great many small parts that can be machined on the ned of a bar in the turret lathe much more quickly than they can be made from castings. There is more waste of stock, but the method of holding gets the stock off so much quicker that the saving in labor compensates many times for the material lost. Assembly details are another factor. The worst living example is the rear bearing on a Ford engine. Anyone who has stripped his car into its atoms and then tried to take a few atoms to pieces to get at this bearing, and then tightened it up too much, will appreciate it as the world's worst piece of designing.

The trouble with most designers is that they do not get a second wind. They start a job with enthusiasm, get it ready to finish up and then their minds go off onto some other job that they want to get going on. There are very few men who have the imagination, the initiative and the broad view that makes possible an original design that is practical, and who can turn from that kind of work to the routine job of making each separate part in such a way that the cost of making it in the foundry and machine shop will be a minimum. Sometimes I have wondered if the design should not stop with the assembly drawings and an entirely new force of draftsmen, separate from the engineering department, but attached to the production department, take it from that point on.

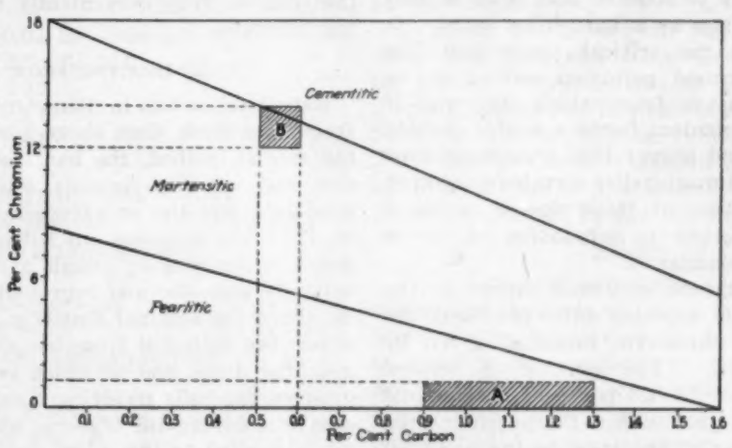
Heat Treatment of Ball and Roller Bearings

By Joseph Kaye Wood
Consulting Engineer, New York City

Required properties of materials for ball bearings—Chrome steel for bearings and its heat treatment—Manufacturing processes—Shortcomings of stainless steel

RELATIVE rotary motion of one machine part to another in which it is supported has given rise to the very difficult problems in the last 30 years. Today, however. the indications are that with the various types of ball and roller bearings available for use, we are, with few exceptions, meeting the current requirements for bearings in mechanical design. For example, ball bearings are giving amply satisfactory service at speeds of 1,000, 2,000 and 3,000 r.p.m., while they have made speeds as high as 30,000 r.p.m. possible.

This result, however, has not been obtained without considerable scientific study, starting with the notable research work conducted by Professor Stribeck in Germany about 25 years ago, nor without the essential co-operation of the steel treater, machinist, metallurgist and the operating or maintenance engineer. Furthermore, this result could not be maintained were it not for the continual devotion of the manufacturer of ball and roller bearings to the virtues of skill and accuracy. Nowhere in the engineering profession is the importance of accuracy better exemplified.



Constitutional diagram for chrome steel (Guillet)

It is, of course, well known that the fundamental purpose of ball and roller bearings is to reduce friction, thus increasing the efficiency of the machine and producing a smoother and quieter running condition. Secondary purposes, as embodied in modern design, are to provide for a certain degree of misalignment of the rotating part and to bear end thrusts. Stribeck found that the safe maximum load for a ball is approximately proportional to the square of its diameter which relation he expressed as follows:

$$\text{Specific load} = k = \frac{p}{d^2}$$

in which p is the load on the ball in pounds and d is the diameter. Under severe shocks or overloads, k may reach a value as high as 30 pounds per square inch.

In order to enable the balls to withstand the high compressive stresses set up by such loads on the small contact surfaces, extreme hardness is required. This hardness, which should be about 650 to 700 Brinell, can be obtained with ordinary carbon steel, but the corresponding lack of toughness and fatigue strength makes such a steel undesirable for ball bearings. Chrome steel has been found to have the right hardness and at the same time to have great fatigue strength and toughness. Peculiarly enough no other steel has so far been found to be as suitable for this purpose, with the result that chrome steel is universally used. The required properties for a ball bearing material as fulfilled by chrome steel, are as follows:

1—Extreme Hardness (650 Brinell)
2—Toughness
3—High fatigue strength
4—Resistance to wear or great cutting hardness.

In addition to these general requirements, a ball bearing may have to be non-corrosive, in which case the non-ferrous metals or stainless steels would have to be used, although they are greatly inferior to chrome steel. However, if the transmitted load is small and very little frictional resistance is required, they may be used to advantage.

Importance of Manufacture of Ball Bearings

The manufacture of ball and roller bearings is as important as the selection of material, since, if the balls vary a slight amount in size, serious overloading of the larger sizes will occur. It is a remarkable fact that steel balls are being produced on a commercial basis within limits of plus or minus 0.00005 to 0.0001 inch.

The chrome steel used in the manufacture of ball bearings usually conforms with the chemical analysis specified by the Society of Automotive Engineers and, in the extreme cases, will not vary in carbon or chromium content more than 10 per cent either side of the range given in this analysis. The extreme limits

as embodied in four separate specifications of this society are as follows:

	Minimum Per Cent	Maximum Per Cent
Carbon	0.9	1.3
Chromium	0.9	1.3
Manganese	0.20	0.45
Sulphur		0.03
Phosphorus		0.03

In other specifications silicon varying between 0.1 and 0.2 per cent may appear, while in others the sulphur and phosphorus may be held to 0.02 per cent.

The process specified may be any one of three, namely, the crucible, electric or open hearth, and the resulting product furnished to the manufacturer is in the form of tubes, bars, wires or forgings. Except in the case of ¾-in. stock which is used to form balls cold, the steel must be well annealed for machining purposes (about 196 Brinell) and as a basis for control in hardening. As is usual in the case of steel bar specifications, it is stated that the bar or tube must be free from inclusions, seams, slivers, etc., and must have a uniform grain structure.

Chromium is very hard and brittle, but it imparts only the former property to steel so that it is, in this respect, superior to carbon as a hardening agent. It has some influence on the critical range and like tungsten causes the critical point on cooling to be lowered as the temperature from which the steel is quenched increases. Chromium forms a double carbide with iron and carbon and proper heat treatment aims to produce a fine-grained martensitic structure together with the complete solution of these double carbides. Poor heat treatment results in separation of excess carbides at the grain boundaries.

The constitutional diagram by Guillet shown in the accompanying illustration explains quite obviously the use of the carbon and chromium range as given by the S.A.E. specification. The portion *A* shaded by the writer covers the 0.9–1.3 per cent carbon and chromium range and is just within the pearlitic area which permits machining of the steel in the annealed condition. Mild quenching readily gives the martensitic fine-grained structure with the maximum of stability, due to the close proximity of the shaded area to the martensitic area. Thus only a slight draw-back in tempering (about 300 deg. F.) is necessary to produce the requisite toughness and freedom from internal strains.

The processes of manufacture and heat treatment are naturally different for the balls or rollers and their respective bearing rings. We shall, therefore, first consider the heat treatment of the rings and then that of the balls and rollers.

In modern practice the rings are forged from solid bar sections by means of bulldozers, at a temperature between 1,800 and 1,900 deg. These are then annealed very carefully by packing them in pots containing charcoal and luted over with clay. The pots are placed in a furnace whose temperature is maintained uniformly by means of thermocouples and pyrometric control. In this way the rings are uniformly heated at a temperature of 1,550 deg. F. for a period of about 10 hours or less, depending upon the number and size of rings in the charge. This insures complete solution of the double carbides.

After cooling down in the furnace to about 950 deg. F., the rings are removed and allowed to cool freely in the air. During the cooling transition in the furnace, the temperature is raised again from 1,000 deg. F. to 1,300 deg. F. and allowed to remain there for about seven hours, after which the rings cool very slowly down to the withdrawal temperature of 950 deg. F. The second heat is kept below the decalescence point to obtain the proper degree of softness for machining, while still retaining the fine-grained structure obtained by the first heating period. Thus a Brinell hardness of about 170 and a very fine-grained structure are obtained. The rings are then drilled and rough ground on the inside and turned on the outside.

Modern practice has dispensed with the use of a barium-chloride salt bath as a heating medium and uses the furnace method instead. The rings are placed in an air-tight cylinder which is placed in an accurately controlled gas- or oil-fired furnace. After a predetermined length of time at a temperature varying from 1,450 deg. F., for small charges, to 1,550 deg. F. for large charges, the rings are plunged into an oil-quenching tank. When cold they are drawn back to from 300 to 350 deg. F. to give the right degree of toughness and to relieve all internal strains. Care must be taken to heat this steel very slowly, a requirement that can be very conveniently met by employing electric furnaces.

Cold-Heading from Wire Stock

Balls ¾ in. or less in diameter are usually cold-headed from wire stock, sizes above ¾-in. being hot forged. In the second method, the bar stock is redrawn to exact size and cut into sections which are placed between semi-spherical dies at a temperature of about 1,800 deg. F. The fins squeezed out between the surfaces of the dies are removed by rough grinding, after which the balls are annealed and reground to from 0.004 to 0.010 in. above the nominal diameter. In the grinding operations the balls fall from hoppers between two vertical grinding disks, one of which is provided with circular grooves, the balls receiving a rotary motion about their own axis during the traverse of the grooves. Paraffine oil is applied to the disks during the grinding operation. Rollers are produced by either the hot forging method, or, in some cases, are turned on the lathe. They are then ground a few thousandths of an inch oversize on an ordinary precision grinder.

In hardening, small pieces are heated to about 1,450 deg. F. and quenched in water, while larger pieces are heated to about 1,600 deg. F. and quenched in oil. They are then drawn to about 300 deg. F. to give the required toughness and to relieve the internal strains. Following the heat treatment the balls and rollers are inspected and tested for fracture. The balls are dropped through a certain height upon a cast-iron plate and then tested for fracture by noting the sound emitted when tapped with a hammer.

The rolling units are next finish-ground on a lapping machine or, in the case of balls, in a tumbling barrel filled with an abrasive. In this operation the high degree of accuracy found in the usual ball bearing is obtained, being in the case of average work about plus or minus 0.00005 in. and, in not a few cases, as high as plus or minus 0.00001 in. The final or polishing operation is done in a wooden rumbler filled with leather and potash.

Balls about ¾ in. in diameter or under are selected for size, or rather automatically gaged for accuracy of

diameter, by special ball-gaging machines. These consist of a hopper for holding the balls and a slide through which they roll when being gaged. The slide, which is the measuring device, consists of two straight edges, the space between the edges gradually increasing in width as the slide extends from the hopper. From the straight edges they fall through into containers, thus being selected according to size. The increase in the opening between the straight edges usually varies about 0.005 in. from end to end.

The Hirth minimeter is generally used for very fine gaging of ball and roller bearings, including the rings. This instrument is extremely sensitive, readings as fine as 0.00005 in. being obtained with it. Hence it is especially adaptable for determining the accuracy of diameters and spherical form. Various other methods are also used, such as the multiplying lever type of gage with attached dial.

When it is practically impossible in service to keep corrosive agents such as sea water from gaining excess to the bearings by the use of grease filled housings or labyrinth glands, it is natural to turn to phosphor bronze or similar alloys as a material for ball bearings. Since these are greatly inferior to even ordinary steel bearings, they are prohibitive in machines designed for high speed or heavy bearing pressures. With the advent of stainless steel—a high chrome or chrome-nickel steel which can be hardened to a Brinell hardness of about 600 and has other high physical properties—it was felt that the proper rust-proof material had been found for ball bearings.

Hultgren, however, in a paper on "The Carrying Capacity of Ball Bearings made of Stainless Steel" presented at the annual meeting of the American Society for Testing Materials on June 25, 1924, in Atlantic City, gives us reason to feel very much discouraged as regards the possibility of this steel for use in ball bearings. In a brief summary of the results of tests made on stainless steel ball bearings during the past 16 years in the Gothenburg Laboratory of Aktrebolaget Svenska Kullagerfabriken, he says, "Ball bearings made of stainless steel, at least of the type tested, seem to be very much inferior to ball bearings made of ordinary material as regards carrying capacity and only slightly superior to such bearings made of bronze. With such results at hand, it is not likely that stainless steel will be used for ball bearings to any great extent. Perhaps properly designed roller bearings of stainless steel will have sufficient carrying capacity to justify their use in cases where non-rushing material is absolutely necessary and the load is not too heavy. This remains to be tested in the future."

The chemical composition and hardening procedure in the case of the various stainless steels tested were as shown in the list on this page.

As a matter of comparison, the carbon-chromium range given above for the American stainless steel is placed on the constitutional diagram shown in the figure previously noted. It is apparent that in this stainless steel, the structure is cementitic after treatment, which accounts for the lack of hardness necessary for ball bearings.

Bearings which pass the impact inspection test and have been in service some time, will occasionally fail by flaking. This is due in part to the tangential stresses set up and in part to the method of manufacture. Of the latter cause it might be said that, aside from improper heat treatment and grinding, the fault is inherent due to the manner in which the balls or rings are pressed in the forming die.

Effect of Grit

Fatigue failure might also result from the initiation of flaws on the balls or rollers by grit which has gained access to the interior of the raceways. This is bound to occur to some extent, no matter what precautions are taken, hence it is very important to have the proper type of lubricant in the bearing. The writer recalls having tested a new lubricant consisting of a mixture of spermacetti wax and vaseline in an enclosed bearing. The lubricant is applied by spraying a solution of it in carbon tetrachloride on the surface, thus producing a very fine and uniform film after evaporation of the solvent. It had been found to give excellent results when used on open flat surfaces, but, when it was used in the bearing, the wear was greater than as if no lubricant had been used.

Repetition of the test consistently gave the same results and led to the probable explanation that the lubricant was in some way acting as a vehicle for grit and small metallic particles. Upon further investigation this was found to be the case, the lubricant not being mobile enough to completely envelop the particles of grit. The grit, therefore, tore the fine uniform film of lubricant and it became "mealy" in appearance. In this condition, it was ideal for retaining the grit particles which, after a short time, tore metallic particles from the bearing. In the same manner the metallic particles were retained in the bearing and from this point on the wear was greatly accelerated.

Pits due to corrosion also lead to fatigue failure and, for this particular service, it is hoped that the combined efforts of the metallurgist and ball bearing manufacturer towards producing a rust-resisting steel ball bearing will meet with success.

American Stainless Steel

Composition:

Carbon	0.05 to 0.60	per cent
Chromium	12.0 to 14.0	"
Manganese	0.30	"
Silicon	2.0	"
Phos. and Sul.	0.015	"

Heat Treatment:

Quenched in oil from 1,832 deg. F.
Tempered to 482 deg. F.

British Stainless Steel

Composition:

Carbon	0.35 per cent
Chromium	12.2

Other constituents not determined

Heat Treatment:

Quenched in oil from 1,742 deg. F.
Tempered to 482 deg. F.
Brinell hardness, 476 to 499 (5mm., 750 kg.)

Swedish Stainless Steel

Composition:

Carbon	0.30	per cent
Chromium	15.45	"
Nickel	0.20	"
Manganese	1.00	"
Silicon	0.34	"

Heat Treatment:

Quenched in oil from 1,922 deg. F.
Tempered to 392 deg. F.
Brinell hardness, 550 to 603 (5 mm., 750 kg.)

Book Reviews

Charles Proteus Steinmetz, a Biography. By J. W. Hammond. Four hundred and eighty-two pages, 6x9 in. Cloth boards. Illustrated. Published by the Century Co., New York City. Price $4.

Mr. Hammond has done a very creditable work in his biography of Charles Proteus Steinmetz. The reader gathers that his task was difficult because of Mr. Steinmetz's inclination to avoid publicity, applause, even fame. Yet the difficulities must have been softened from the same cause; Mr. Steinmetz's nature and personality had made only friends, who could not have forgotten the doings and sayings, the little "humanities" that are the heart of a biography. The engineering accomplishments of the man are matters of record.

While he lived, Steinmetz by what he did held the interest of those who knew of him but did not know him. While we marveled at his works, and profited by them, we wondered about the man himself, how he treated the commonplaces of life, what were his pleasures, what, beside fame, the world gave to the big, little, deformed man. We are happy to find that he enjoyed fully almost every minute of his life.

America is proud of its self-made men and likes to read of them. There is no disappointment in store in this life of Steinmetz. He came to America in 1889 penniless, in fact owing for his passage, and his rise to the high position he held with the General Electric Co. was made entirely by his own efforts.

During his progress from obscurity he presented before the American Institute of Electrical Engineers his famous paper on the law of hysteresis and introduced his symbolic method of alternating current calculation. Later he served as president of the A. I. E. E., wrote text books and for about ten years occupied the chair of electrical engineering in Union College. He made developments in arc lighting and interested himself in transportation. He even stepped into politics for a short time.

Throughout his life Steinmetz was a nature lover, and was more than ordinarily fond of children and animals. He was a confirmed addict of home life and cigars. His whimsicalities were productive of numerous pleasing anecdotes.

Mr. Hammond has caught the significance of the things that Steinmetz did, little as well as big, and it will be very much worth your while to get acquainted with this man of history through Mr. Hammond's biography.

Making the Tariff in the United States. By Thomas Walker Page, with the aid of the Council and Staff of the Institute of Economics. Two hundred and seventy-three pages, 5x7 in., cloth boards. Published by the McGraw-Hill Book Co., Inc., 370 Seventh Ave., New York City. Price $2.50.

The tariff is one of the economic subjects about which we may feel that our knowledge is sufficient until we read a book such as this one by Mr. Page and the Institute of Economics. After the reading, our views are quite likely to be more flexible. And if they are, so much the better; there is no especially good reason to have a closed mind on tariff problems.

In brief the book (as specified in the introduction) indicates that "there is no hope of better results from the unmethodical procedure commonly followed in making the tariff"; explains why the remedies hitherto attempted have failed; discusses the information needed for making the tariff, to show what part has been lacking; and suggests means by which the missing information can be procured. The recommendations made relate to procedure in legislating and not to policy.

The means referred to consists of the assembly and interpretation of the facts of trade and industry. It is pointed out that this means is identical with that necessary for perfecting tariff policy.

The book recommends the maintenance of a permanent independent tariff commission to furnish Congress and the country with information showing what the duties ought to be. It recognizes the inability of Congress to find for itself the information necessary in making the tariff. The commission would show "industrial organization, methods and processes as practiced in America and in the chief competing foreign countries."

The assumption on which the commission should work is "that the rates of duty are to be such as will maintain equality of opportunity for foreign and domestic industries." It should be noticed that, even though information were collected to this formula, the duties would not necessarily be set to it.

One of the most valuable features of the book is its service in pointing out and analyzing the great number of influences affecting duties. With so many variables the wonder is that our tariff works as well as it does. Whether or not the reader agrees with the proposed solution of tariff-making troubles, his time with the volume will have been well spent, because of his greater acquaintance with the quantity and seriousness of tariff problems.

Recent Progress in Engineering Production. By C. M. Linley, Civil Engineer, London. Cloth, 7x10 in., 340 pages, 303 illustrations. Published by Ernest Benn, Ltd., 8 Bouverie St., London, E. C. 4. Price 42 shillings net (nearly $10).

This book has been written with the object of keeping engineers, manufacturers of machinery, and all those who operate mechanical plants, in touch with developments and improvements in connection with machine tools, shop practice, manufacturing methods, processes and alloys.

The improvements described are mainly those which tend to reduce the cost of production and which at the same time should enable the manufacturer to produce a better and more saleable article.

The author has endeavored to deal with his subject in dispassionate spirit. Where specific machines or pieces of apparatus are recommended, the recommendation is made as a result of his own practical experience, or because the idea or design incorporated appeals to him as efficient and workmanlike.

In nearly all instances, information has been included which will enable the reader to get into touch with the manufacturers or agents who can supply the particular article. Among the great number of machines mentioned or described, machines of American make have a fair representation.

The book is well written and attractively presented by the publishers. It makes stimulating reading for those who have to do with shop equipment or manufacturing methods. The American reader will also be interested in the information supplied by the author on European machinery and shop practice.

A.S.T.M. Tentative Standards, 1924 edition. Published by the American Society for Testing Materials, 1315 Spruce St., Philadelphia, Pa. 763 pages, 6x9 in., illustrated. Price $7 in paper and $8 in cloth binding.

The term "Tentative Standard" is applied to a proposed Standard which is printed for one or more years with a view of eliciting criticism, of which the committee concerned will take due cognizance before recommending final action toward the adoption of such Tentative Standard by formal action of the Society.

The Standards and Tentative Standards of the American Society for Testing Materials are recognized as authoritative in the field of engineering materials and will undoubtedly prove of interest to the readers of the *American Machinist* (especially groups A and E as given below).

The book contains 185 Tentative Standards as follows:

A—11 relating to Steel and Wrought Iron.

B—18 relating to Non-ferrous Metals.

C—28 relating to Cement, Lime, Gypsum and Clay products.

D—123 relating to Miscellaneous Materials.

E—5 relating to Testing.

Two items in group A present a special interest. These are Tentative Specifications for:

1. Carbon Tool Steel (Serial Designation A 71-24T), pages 15-20.

2. High-Speed Tool Steel (Serial Designation A 92-24T), pages 21-24.

The E group, relating to Testing, contains the following interesting subjects:

Serial Designation	Subject
E 8—24 T	Tension Testing of Metallic Materials
E 9—24 T	Compression Testing of Metallic Materials
E 10—24 T	Brinell Hardness Testing of Metallic Materials
E 4—24 T	Verification of Testing Machines by Means of an Elastic Calibration Bar
E 6—24 T	Terms Relating to Methods of Testing

The various articles in this book are written in a clear and systematic way and present a wealth of data to the interested reader. They are in many cases profusely illustrated.

Annual Report of the Smithsonian Institution, 1922. Publication 2,724 of the Government Printing Office, Washington, D. C.

The annual report of the Smithsonian Institution for the year ending June 30, 1922, covers these subjects:

1. Annual report of the secretary, giving an account of the operations and condition of the Institution.

2. Report of the executive committee of the Board of Regents, exhibiting financial affairs of the Institution.

3. Proceedings of the Board of Regents.

4. General Appendix, comprising a selection of miscellaneous memoirs of interest to collaborators and correspondents of the Institution, teachers and others.

Among the memoirs is a paper "Aeronautic Research," by Joseph S. Ames, Professor of Physics, the Johns Hopkins University, Baltimore, Md., Chairman, Executive Committee, National Advisory Committee for Aeronautics. The paper was presented at the meeting of the Section of Physics and Chemistry of the Franklin Institute, held Oct. 6, 1921, and is reprinted in the report by permission from the *Journal* of the Franklin Institute, issue of January, 1922.

A Method of Handling Tire and Wheel Work—Discussion

By F. M. A'Hearn

While the method of cutting the tire for removal by use of the torch, as described by H. K. Griggs, under the title given above on page 587, Vol. 61, of the *American Machinist*, has certain advantages, it also puts the tire beyond salvage possibilities, except as scrap.

When it is remembered that many types of locomotives require tires of 3-in. thickness when first applied and that the tires are removed at thicknesses varying from 1½ to 2 in., it is apparent that less than 50 per cent of the new tire is service metal. The remainder is usually scrap. Part of this loss may be avoided by transferring worn tires from heavy to light power having the same size wheel centers.

If tires are removed by expanding, instead of by cutting, it will be found that possibly 50 per cent of removed tires may be re-assembled into sets of sufficient thickness to give an additional service of 40,000 miles. One badly worn flange in a set of otherwise fair tires will require a removal of ¼ in. of tread-metal in turning the set.

One method that has proved satisfactory is to sort all removed tires into sets of generally uniform diameter and contour, and reset and turn them. This gets all possible service from tires. Tires when made, are usually assembled into sets, all taken from the same heat to insure uniform hardness. The method suggested does not carry out this practice, but is permissible in salvaging worn tires.

Tires Bored to Fit Wheels

Wheel centers, where tires are held by shrinkage only, may be maintained sufficiently uniform in diameter to allow new tires to be bored when delivered from the maker. New tires thus handled are held in stock ready to be applied as needed. In case a wheel center is found slightly under size, a suitable liner can be applied between it and the tire. All wheel centers provided with recesses to receive shouldered tires should be machined to a maximum over-all distance. This permits boring all tires the same depth to the shoulder. Shrinkage allowance of 1/60 in. per foot in diameters of 66 in. or over, and 1/80 in. per foot for wheel centers less than 60 in. diameter, will give good results. The wheel centers are considered to be the nominal sizes, the tires being bored smaller by the required amount.

Solid wheel and tire gages are successfully used in many shops. A ⅜-in. pipe with plugs welded in the ends, the plugs hardened and ground to size, or a piece of drill rod with the ends hardened and ground, and held between two pieces of ½x1½-in. hard wood, grooved to receive the rod make good tire gages. The wood should be of such length as to allow the rod to project.

Wheel-center gages are of somewhat similar construction to the tire gages, except that the ends of the pipe or rod stand at a 90-deg. angle with the body. The ends should be about 8-in. long and the tips turned toward each other for a distance of perhaps 1½ in. A steel scale of suitable length, provided with stops or slide blocks, will be found sufficiently accurate to use as a reference in making and maintaining the gages.

While the foregoing methods may appear rather crude, they have been successfully practiced for a number of years, with tire troubles on heavy service power so infrequent as to be considered negligible.

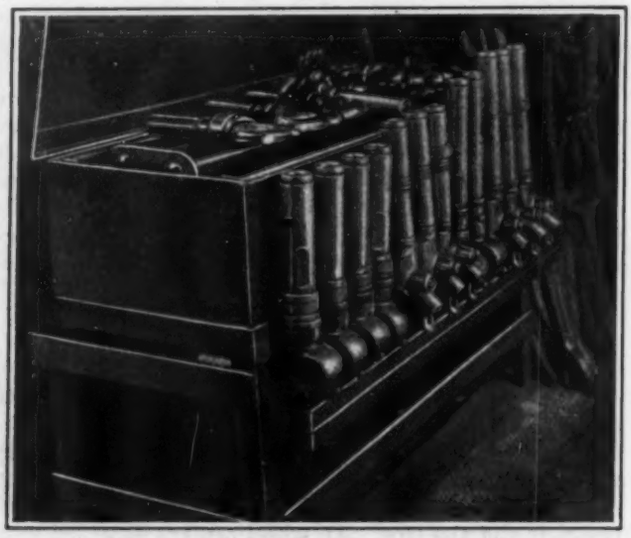
Ideas from Practical Men

Devoted to the exchange of information on useful methods. Its scope includes all divisions of the machine building industry, from drafting room to shipping platform. The articles are made up from letters submitted from all over the world. Descriptions of methods or devices that have proved their value are carefully considered, and those published are paid for

Lubricating Tank for Pneumatic Tools

BY TOM J. O'REILLY

In order to insure that the hammers will be properly lubricated, as well as to assist in keeping them clean, all pneumatic hammers in use in the El Paso shops of the Southern Pacific Railway are placed in a tank of oil each night and are left there until morning. The chipping hammers are laid on a shelf part way down



Oil-bath for pneumatic tools

the inside of the tank and the riveting hammers are placed on the bottom of the tank. The tank, which is shown in the illustration, is kept approximately two-thirds full of oil, or full enough so that the hammers will be covered. In the morning the hammers are taken out, the chipping hammers are laid on bars across the top of the tank and the riveting hammers are placed on end on an extension drip-pan, as shown, to drain. In this manner the tools are assured of an oiling every day and are kept cleaner and in much better condition than formerly.

Beauty Clay for Babbitting Bearings

BY HOWARD J. BURNISH

In babbitting bearings it is advantageous to preheat the babbitting mandrel, also the shell to be babbitted, from 100 to 250 deg. F. But this does not completely solve the problem of securing a homogeneous bearing.

After considerable investigation on various sizes and types of bearings for heavy crushing machinery, some as large as 18-in. diameter by 60 in. in length, I have found a method which aids greatly in securing a good bearing. By making a mixture of ladies' clay and water to the consistency of medium lubricating oil and painting the mandrel after it has been heated, a coat of from 0.003 to 0.004-in. thick is added. This coating draws the moisture from metal which enters at the pouring gate and practically insures a solid bearing.

A Non-Slip Washer and Block for Toolposts

BY CHARLES F. HENRY

I wonder why it usually seems necessary to do things the wrong way at first. It isn't always true, of course, but it happens very often. One of the shining examples of how not to do it is the sliding block in the toolpost of an engine lathe. How many thousand lathes with toolpost washers and blocks, as shown in Fig 1, have been inflicted upon the lathe-using public?

A curved block is very handy for adjusting the height of the tool but why curve it the wrong way? With the block made as shown in Fig. 1, the pressure of the cut on the tool point tends to slide the block and lower

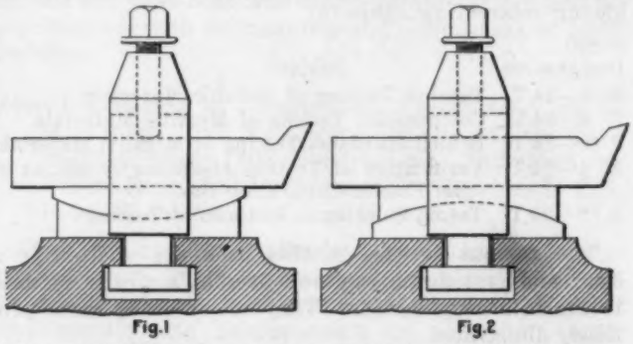


Fig. 1—Toolpost washer and block as usually made.
Fig. 2—Toolpost washer and block of good design

the point. That is why so many toolposts of this type are broken or ruined by the lathe hand using a piece of pipe on the wrench. The least damage is mushrooming the screw point.

A few bright souls have changed this by reversing the curve on the adjusting block, as in Fig. 2. Reversing the curve gives the same height adjustment, but the tool pressure forces the block against the base instead of tending to slip it on the curve as in the usual design. The tool is held with a much lighter pressure of the screw and there is no tendency to break toolposts or mushroom the ends of the screws.

There is still another advantage to form of block and washer shown in Fig. 2. The washer sheds the chips, while the old style makes a nice resting place for the chips where they interfere with both the setting and the holding of the tool.

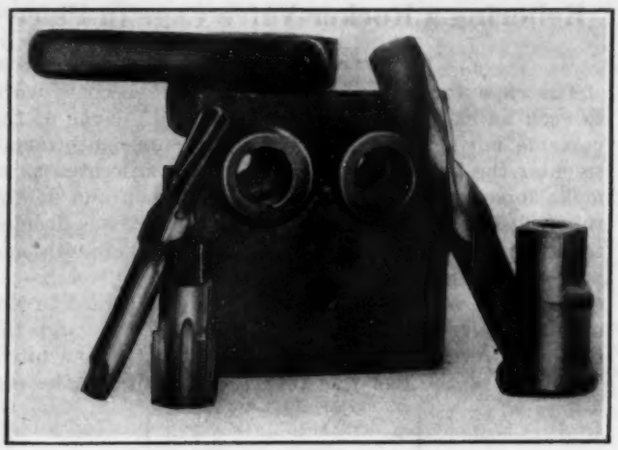
The idea is not original with me. It is possibly older than the *American Machinist*. But even though it was never adopted to any extent, it bears out Professor Sweet's contention that many things are usually wrong.

Jig for Machining Cylinder-Cock Bodies

By J. H. Hahn

The illustration shows a jig for machining cylinder-cock bodies for use on locomotives.

The bodies are used in large numbers on both new and repair work in railroad shops. They are generally of cast iron and there are three operations, reaming, drilling and tapping. The jig was designed for use on



Jig for bodies of cylinder cocks

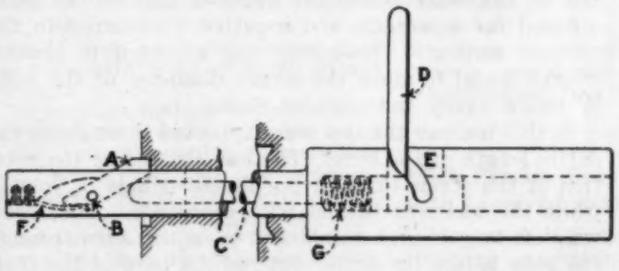
a drill press and the special reamer shown reams the body for the valve seat and also for the valve stem, at one operation. The body is then drilled and tapped for 1¼-in. pipe. The hole shown in the center of the jig is used for bolting it to the drill-press table.

Two of the valve bodies are shown in the jig and a finished part is shown at the right.

Counterboring and Back-Facing Tool

By K. H. Crumrine

The appended sketch shows a tool to be used for back-facing, counterboring or similar operations upon work that is in progress upon a hand screw-machine or turret lathe. By making the cutting tool *A* of suit-



Tool for back-facing in screw-machine

able shape and length it may be used as well to produce concaved or semi-spherical seats in the work.

The large end of the holder is made of suitable diameter to fit the turret of the machine. The small end in which the cutting tool is carried is of suitable size to fit the hole that has already been drilled and reamed in the work. This part of the holder should be hardened and ground.

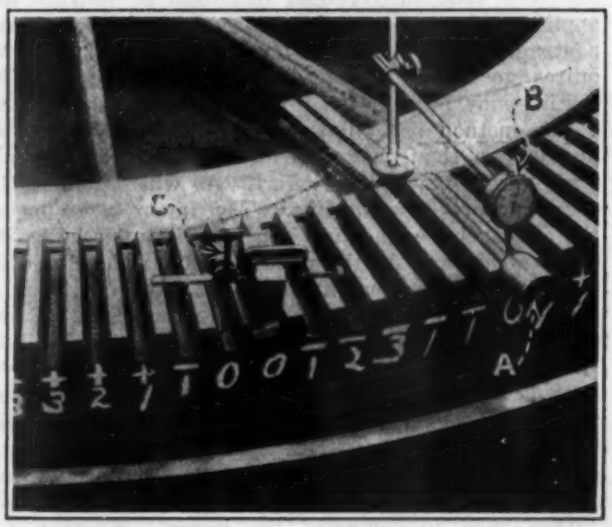
The cutting tool is a close fit in a slot milled in the holder, and is hinged on the pin *B* so that it may be swung out to working position as shown in the sketch. After the cut has been finished, the tool is returned within the diameter of the bar so that the latter may be withdrawn from the work.

The pin *C* is used to bring the tool *A* into its working position, and the pin in turn is caused to move forward and back by a partial rotation of the lever *D* in the cam-slot *E*. The flat spring *F* causes the tool *A* to move inward when the pin *C* is withdrawn. The coil spring *G* is intended to prevent the pin *C* from moving forward accidentally, but is not strictly essential to the working of the tool.

Securing Accuracy in Boring-Mill Gears

Some idea of the care with which modern machine tools are built can be had from the method used by the Cincinnati Planer Co., to inspect the large bevel gear for one of its 96-in. boring mills in order that the work of the completed machine may be of the highest accuracy. The gear is bolted to the underside of the boring mill table which has been turned upside down to make inspection easy.

The bearing or track on which the table rides is used as a base for checking the gear, as the track is



Testing the accuracy of large bevel gear teeth

machined at the same time that the seat for the gear is faced off, so that both are in the same plane. A ground plug *A*, of the proper taper, is placed between the teeth and shouldered up against the outside diameter. Then the base of the indicator *B* is placed against the bore of the gear at each reading.

The other indicator, *C*, has a bearing on top of the tooth, and also a bearing on the side. The side bearing of the base is relieved in the center so as to make sure that it seats itself properly on the tooth curve. Then an indicator pointer is placed against the next tooth. In using the indicator from tooth to tooth, the reading of the tooth spacing is obtained.

The test with a taper plug is an old method, but the method of testing the spacing is believed to be fairly new, since it does not seem to be in use anywhere else.

We are indebted to George Langen, works manager of the Cincinnati Planer Co., for the illustration and data.

Bending Iron Castings

By F. M. A'Hearn

Long castings of gray iron, such as columns or beam-shaped sections, are sometimes badly warped when taken from the sand. When the castings are not to be machined, a practice sometimes resorted to is to peen the inner or short side of the curve, thus expanding the surface metal sufficiently to cause the casting

Straightening bent castings

to straighten by reason of the strain imposed on the peened surface.

Machine frames that have passed through fires are sometimes slightly warped, and if they are to be resurfaced they do not in all cases contain sufficient material to finish unless they are first straightened. Peening will not give permanent results where the peened surface is removed in machining.

A method quite generally practiced is to lay the casting, suitably supported at the ends, with the bend upward and heat the bent section. After the metal has been sufficiently heated to soften it, weights are applied to the casting to bend it downward into as near a straight line as can be obtained. The method requires good judgment and careful watching, or the casting may be bent too far in the opposite direction.

The method here illustrated, while requiring more preparation than that described in the previous paragraph, will pay for the effort. As will be noted, the four supports are in line. The inner two support the casting before heating when the latter is laid with the bend down. As the metal softens, the outer ends settle upon the outward supports, which form a stop and prevent too much bend in the piece. If the supports have been carefully lined, the results will be satisfactory.

It is believed that bending in this manner compresses the metal at the under side of the bend, since the under side is heated to a higher degree than the upper and is more yielding. If the bend is upward the tendency would be to stretch the under surface rather than to compress the upper. Whether the method is of value or not depends largely on the shape and use of the piece straightened.

Making Chuck-Jaws

By H. Beard

Recently, the boss bought at a Government surplus sale among other things, a new 18-in., 3-jaw, universal chuck, with only one set of non-reversible jaws. The chuck had no maker's name on it, so it was up to us to make a new set of jaws of the opposite hand. Of course, we could have annealed the jaws that came with the chuck and fitted false jaws, but we have never been able to get satisfactory service out of such jaws except for special jobs.

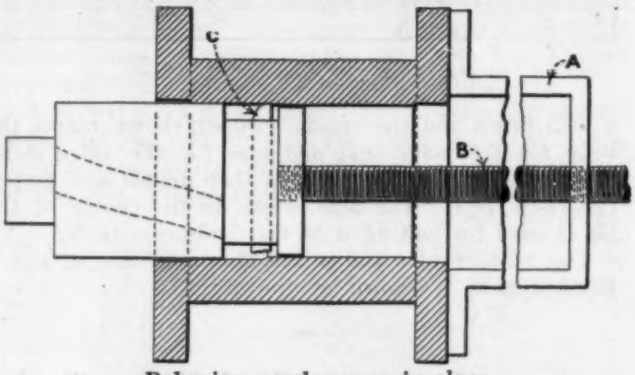
So we fastened three suitable blocks of soft steel to the faceplate of a 20-in. lathe, in their relative positions and disassembled the chuck. We mounted the scroll on a flange that was bored and keyseated to a sliding fit on a mandrel fitted with a collar and spring, to keep the scroll in place while feeding and withdrawing the cutting tool. We then mounted the assembled scroll and mandrel between the centers of the lathe, clamped one of the chuck jaws to the compound rest so as to engage the scroll and act as a lead nut. With the cross-feed nut disengaged and with a suitable tool in the tool post we were ready for action. In a very short time we cut teeth in the jaws to match the scroll. The rest was all plain machine work and required no special appliances.

Reboring a Rocker-Valve Cage in Place

By F. M. A'Hearn

The cage for a rocker-type valve had become worn to such an extent as to require reboring. None of the portable boring outfits at hand were sufficiently small to enter the bore, and the cylinder was so located as to make it very inconvenient to take it down and do the reboring in the machine shop; therefore it was decided to fit up a tool as shown in the sketch herewith and bore the job in place.

A yoke *A* was made of suitable length, drilled to slip over the valve-cage cover-studs and tapped through the center to receive a stock-size staybolt *B*, of fine pitch. The body of the tool was turned a slip fit for the end



Reboring a valve-cage in place

of the valve-cage for a short distance. Beyond this diameter the body was reduced to provide chip room, and farther back was increased to what was considered to be the required diameter to clean up the worn part of the cage. The feed screw *B* was fitted into one end of the body piece, the opposite end of the body squared for a wrench, and a cutter, *C*, secured in the reduced section. The cutter was adjusted to remove enough metal to allow the larger diameter of the body to follow easily but without shake.

In this manner the tool was supported throughout the entire length of the bore. The bar was fed by the rotation of the screw through the threaded hole in yoke *A* while the tool was turned with a wrench. The screw was left long enough to allow it to be threaded through the yoke before the cutter entered the bore of the cage. It was first thought that flutes should be cut in the body piece, as shown by dotted lines for chip clearance, but it was later decided to omit them, as the chips would fall into the ports.

The first cut did not clean up the worn surface entirely, and so the body of the tool was turned down and light brass rings driven on. The first ring was made to suit the increased diameter of the bore and the second ring made larger to guide behind the cutter. After the second cut was taken, very little scraping was needed to fit the seat to the new valve, completing the job in a satisfactory manner.

Technical Abstracts

Inside a Germany Factory

C. W. Goerling, of the Union Special Machine Co., has been tackling management problems in Stuttgart, Germany, and writes interestingly of the problems he experienced.

The fall of the mark made factory management difficult in a good many ways. All purchases had to be paid for before delivery, but if the mark had fallen considerably between the time of sending the money and the time it was received, additional payment had to be made. Of course, when the factory sold its product a similar payment could be demanded, but this was not complete protection. New ideas in labor relations are being tried out—both labor unions and manufacturers' organizations have official status and both exercise some control over the affairs of the individual factory. The industrial councils also have official standing and power. Pervading the entire industrial life was a feeling of despair and hopelessness varied only by unrest.

Since the rentenmark was established in 1923, there has been some improvement and the more spectacular difficulties are probably disappearing. Mr. Goerling's company is shipping machines to Germany from its American plant to fill a demand greater than the German plant can meet. However, some of the problems due to the changes caused by the stress of war will still continue. One of the immediate results is the appalling expense of making changes that an American factory of the same size would make without hesitation. For example it was impossible to replace old wooden bins in the stock room with flexible shelving. On the other hand, other equipment is quite easily obtained, such accessories as drinking fountains and good office equipment being obtained without difficulty.

One peculiar feature is that American management would be handicapped by the lack of available records as most German factories are what we call one-man shops—the factory manager carrying all valuable information in his head and recording very little on paper. This man keeps in close touch with every angle of the factory's business imparting to others only as much knowledge as he has to in order that they may fill their own jobs. The pay of the workman is very small. During the first few months of 1923 the pay of the average workman did not reach an equivalent of $1.00 a week and such a situation does not make any workman ambitious or loyal to the factory. Wages and salaries are set by a commission and the commission is virtually run by the unions and manufacturing associations. The unions set the minimum wage and the manufacturing association set the maximum wage. If a factory tried to pay less than the minimum a strike was called, and if, on the other hand, it tried to pay more than the maximum, it was likely to be thrown out of the manufacturing association and lose its business.

On the question as to whether there is any possibility of Germany becoming a competitor of American organizations, Mr. Goerling believes that in many respects German manufacturers are far behind American manufacturers, particularly in standards. It is difficult to gather whether he does or does not think there will be great competition in the future. The conditions he states are so tremendously different that it is impossible to make an estimate.—*Factory*, November, p. 642.

The Calculation of Cutting Resistance

Erich Eversberg continues his discussion of metal cutting. In this second part he goes more deeply into what might be called the mechanics of cutting, establishing among other things expressions for the bending moment on the chip, etc. He finally computes in detail the temperature attained in cutting two metals of known characteristics. These check fairly well with experiments in Manchester in 1903.

We doubt whether the average American machine-tool designer would ever attack his problem with such mathematical detail as is exhibited in this article. Nevertheless, by constant application of such methods and checking the calculated results against practical findings, there is no doubt that finally an excellent evaluation of all the factors influencing the cutting process can be attained.—*Die Werkzeugmaschine*, July 30, p. 377.

High Production with Lowered Accident Rate

Men who are designing and constructing machinery are now incorporating into their designs not only the necessary construction to allow the mechanism to be driven much harder in every way, but also other features of design which allow the operators to turn out their work with less danger from accident and fatigue. There is, however, a feeling at the present time that any noticeable increase in production carries with it an increase in the accident rate. This is natural, because high production generally means high speed and calls for quicker motions from the operator. It is on high speed machines that accidents occur most frequently. The most striking revelation of the analysis by the National Bureau of Casualty and Surety Underwriters was the seriousness of "the point of operation" on machines as an accident factor. Safety engineers have always recognized that unguarded points on machines constituted one of the most prolific sources of accidents, but the high percentage surprised the engineers and research men. In the machine shop industries machinery was responsible for about 32 per cent of total accident costs and the point of operation of machines alone was responsible for 20 per cent. It is revealed that in a good many industries the cost of accidents due to machines, and particularly to the "point of operation" of machines was greater than for machine shop industries. Some of the newer machines have been designed with the idea of removing the point of operation from the operator.

This article has some tables and classifications and also illustrations that show means of dealing with the problem discussed in the article.—*Industry Illustrated*, November, p. 20.

Waste

In this paper, that was the presidential address of Tom Westgarth of the North-East Coast Institution, England, he considers the form of waste in industries that he believes to be far larger and more disastrous than any other form, and that is, the waste of capital and labor and waste of good will between manufacturers and workmen because of the apparently never ending misunderstandings and disputes which take place and cause not only ill feeling, but strikes and all kinds of restrictions to the quick, efficient and cheap execution of the work. This, of course, is written from the British standpoint, and states that the manufacturer does not always realize the anxiety of the workman lest he should be out of work or his health, which is his capital, fail, or an accident happen. Mr. Westgarth is in favor of the workmen being represented upon the board of directors of the company for which they work. Such a man should be able to explain more satisfactorily the views of his fellowmen to his company's directors and, of equal importance, he should make known to the workmen the ideas of his company's directors, of course exercising proper discretion on both sides. England is devoting considerable attention to the economics of production, and is finding, as we are in America, that engineering still can be directed to the larger problems involved in the term "waste."—*The Engineer*, Oct. 24, p. 476.

American Machinist

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KENNETH H. CONDIT AND FRED H. COLVIN, *Editors*

The Mechanical Engineer

HAS the mechanical engineer gone to join the all-round machinist in the land of the dodo and other prehistoric creatures?

We are moved to ask the question by a survey of the program for the annual meeting of the American Society of Mechanical Engineers. One is somewhat dismayed at the technical sessions of this section and that division; at the countless meetings of main committees and standing committees, of subcommittees and working committees; and on top of all this there is the long list of social affairs and the equally enticing suggestions for inspection trips. Really, a three-ring circus is simple in comparison.

But what of the society member for whom all this excitement is arranged? Is it possible that he can be interested in everything that goes on, or even that he can listen intelligently to half of the papers? Certainly not, for the mechanical engineer, the type of man visualized by the little group of enthusiasts that met in the *American Machinist* office forty-odd years ago to found the huge society of today has vanished. Specialization has affected the profession of mechanical engineering as it has everything else in the country. What can the power plant engineer be expected to know of the fine points of steel treating, or the machine tool designer of the idiosyncracies of powdered coal?

No, the mechanical engineer of a generation ago has gone, as has his counterpart the all-around machinist. But in his place has arisen a group of technical specialists each with a more thorough training, a wider experience in his chosen work, than the old timer could hope for. To arrange a meeting that will be constantly interesting to men whose activities are so widely divergent is a serious problem and one that the society will find more and more serious as the years pass and engineering and scientific knowledge increases.

Aviation Development Urged by Secretaries Hoover and Weeks

WE HAVE pointed out at intervals the need for greater attention to aircraft development in this country and to the need both for Federal control and the appointment of an Air Service Secretary. Both Secretary Hoover of the Commerce Department and Secretary Weeks of the War Department, refer to the failure of America to keep step with the progress of aviation elsewhere. The former naturally refers to aircraft for commercial enterprises while the latter has in mind the Air Service of the Army.

Secretary Weeks points out the time required to produce planes in quantity as based on our war experience, when it took 11 months to get an American plane to the firing line. The scattering of aircraft factory workmen, due to lack of orders or other encouragement, would make it equally difficult today.

Another drawback, which the secretary of war does not mention and with which he may not be familiar, is the manner in which some divisions of the War Department deal with manufacturers of aircraft and accessories. There are cases in which designs and patents are entirely ignored and concerns who have had no hand in developing the articles desired, are given the orders. In other cases standard articles are "improved" by officers in such a way as to make manufacture more difficult and more expensive, without in any way bettering the functioning of the device.

Unless we are content to sit by and see even the smaller nations outstrip us in the development of aircraft, we must adopt an aviation policy that will enable those who bring out meritorious designs and devices to receive an adequate reward. And we must prevent the building up of any policy that will discourage legitimate enterprise. In too many instances the money that has been spent for development at government plants has not been productive of commensurate returns. We must have a policy that will encourage private enterprise or we shall be tail-enders instead of leaders.

Development Must Be Paid For

AN INCIDENT that happened at a summer boarding house is applicable to the machine tool and many other industries. A prospect inquired the price of table board and was told that it was $18 a week.

"Eighteen dollars a week—why I couldn't eat eighteen dollars worth of food a week." To which the landlady replied: "I hope you couldn't. If you did where would I get off? I have rent, taxes and servants to pay beside buying the food, and I have to make a little profit too."

In how many cases does the prospective buyer look at a machine and say practically the same thing as the would-be boarder? How often does he consider only the weight of the iron and steel, and possibly the cost of labor, and entirely forget the time and money spent in developing the idea and bringing it to the point where it becomes a productive machine?

This item of development cost may be great or small. It depends on the difficulty of the problem and ability of those who develop it. But it must, in all fairness, be paid for by those who benefit by its use. And the amount of this development charge which must go on each machine depends on the number of machines that can be sold within a reasonable time.

One machine comes to mind on which over a quarter million dollars was spent in development. While it is an excellent machine and an achievement in design and construction, the total market probably does not exceed 350 to 400 units. It is a great time saver, yet the development charge must be at least $1,000 a machine which makes the price seem exorbitant to the buyer.

There are few cases, however, where users have developed their own machines, in which the total costs are not higher than the development charge added by the regular builder. In too many cases they never know how much it really does cost.

Development work must go on if we are to progress. But it must be paid for by the users, who should consider the results obtained rather than the price, in dollars, of the machine itself.

Shop Equipment News

Heim Improved Centerless Grinding Machine

An improved centerless grinding machine, as shown in the illustration, has recently been brought out by the Heim Grinder Co. of Danbury, Conn.

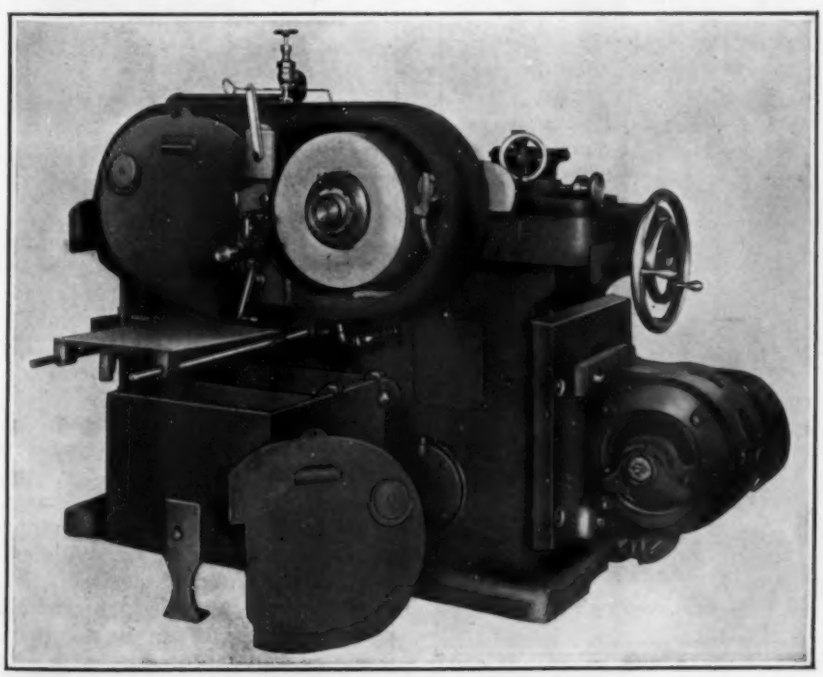
Besides round work of uniform diameter, the machine will grind tapers, shouldered pieces, irregular contours and parts that do not present a complete circumference; as twist drills that have been fluted and relieved.

The base of the machine is of the cabinet type, housing the main shaft from which the grinding-wheel spindle is driven, and also a differential countershaft that is one of the factors in determining the rate of feed. The machine may be driven by either motor or belt.

An endless belt within the base drives the grinding wheel at a uniform speed. The differential unit is belt-driven from the first shaft through a pair of cones, and is provided with an internal-gear speed-reduction device. From this unit, the spindle of the second, or "regulating" wheel is driven at a speed that may be varied to suit the nature of the work. To otain a high speed for dressing the wheel, the speed-reducing device may be thrown out of action by means of a conveniently located handwheel.

Both wheel spindles are carried in slides bearing upon the upper surface of the machine bed and capable of movement horizontally at a right angle to the center line of the wheel spindles. These slides are independent of each other and are actuated by means of screws operated by handwheels. The position of the slides governs the diameter of the work, and the smaller handwheel is graduated to assist in maintaining accuracy in this respect.

The spindle of the regulating wheel may be inclined in a vertical plane to any angle from 0 to 6 degrees. The angle of inclination is one factor determining the feed in "through" grinding; the other is the rotative speed of the regulating wheel.



Heim Improved Centerless Grinding Machine

The spindles run in split-sleeve bearings of bronze, tapered upon the outside and fitted with ring adjusting nuts to compensate for wear. The journals of the grinding-wheel spindle are longer than the bearings and provision is made for automatically oscillating the spindle endwise for securing a smooth surface upon the work and to prevent the wheel from wearing unevenly. Ball thrust-bearings, fixed in the case of the regulating wheel spindle and adjustable in the case of the grinding wheel spindle, confine the spindles against endwise movement; the former at all times and the latter when the shape of the work will not permit such movement.

Upon each of the main slides there is mounted a wheel-truing fixture consisting of two members, the lower one resting upon the top of the wheel slide and pivoted to it so that it may be swiveled in a horiztonal plane through an arc of 10 deg. to either side of the central position.

On the inner end of the upper slide is mounted a circular diamond-carrying bar having a movement at a right angle to that of the slide. One end passes inside the wheel housing, and at the other end is a stud that bears upon a formed guide-plate which determines the contour produced by the diamond upon the face of both regulating and grinding wheels.

The diamonds are carried in adjustable holders and are always in position for immediate use, so that a cut may be taken across the face of either wheel without disturbing the set-up. Each holder is connected to the coolant system.

The upper face of the rest for grinding straight work is a rectangular strip of hardened steel and is so held that it can be turned to bring any one of its four faces uppermost. When all faces show signs of wear it may be redressed, or a new strip substituted. The rate of feed may be adjusted from zero to 80 ft. per min., depending upon the speed of the regulating wheel and the angle to which its axis is inclined.

Various fixtures are provided to hold tapered or shouldered work.

Provision is made to handle work automatically, the fixture in this case being actuated by a mechanism on the back of the machine and driven through helical gears from the rear end of the regulating wheel spindle.

In grinding parallel shouldered-work, the faces of both wheels are trued parallel with their axes and a slight oscillation of the grinding wheel spindle is permissible. For tapered work, the face of the regulating wheel is beveled to the included angle of the taper. The spindle of the grinding wheel may be allowed to oscillate, but no endwise movement of the work can be permitted.

To grind work of irregular shape, both wheels are dressed to the corresponding contour, and the upper face of the wearing strip must be machined accordingly. No end movement either of work or wheel spindle may be allowed.

The grinding wheels are inclosed in a housing that effectually confines the cooling medium. The front of the housing is closed by easily removable covers, permitting ready access to the wheels for changing. A coolant tank, provided with straining and settling chambers, is bolted to the base of the machine in such position that the liquid drains from the hood by gravity. A centrifugal pump furnishes the means of circulation.

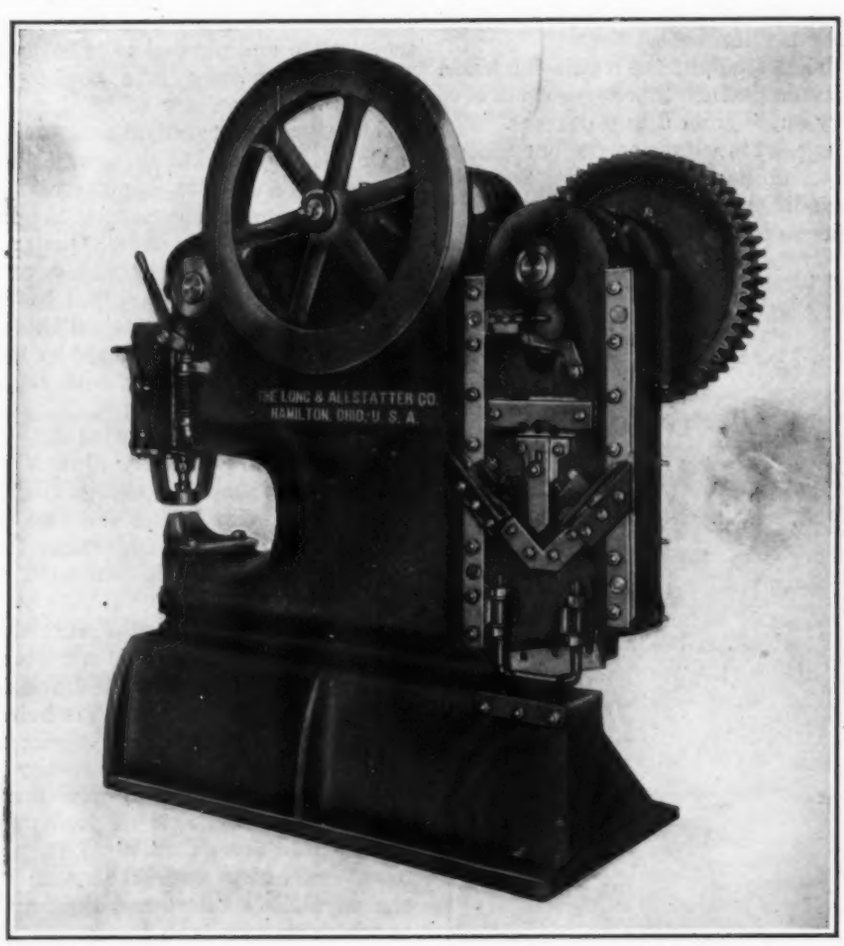
The machine covers a floor space of 3 ft. 9 in. by 7 ft., and weighs 4,850 lb. net.

Long & Allstatter No. 2 Combination Shear and Punch

A punching and shearing machine for general service is being brought out by the Long & Allstatter Co., of Hamilton, Ohio. It is claimed that this machine performs effectively the following operations: punches holes in plates, angles, structurals, and other shapes; shears angles (square or mitered), rounds, squares and flats; and split plates. It is not necessary to change tools for any of the operations mentioned because the punching tools, as well as the various blades, are always set up and ready for use.

The main frame is an annealed casting. The shear slide is of steel and slides in bronze liners. The punch slide has a lowering device which enables the operator to gage more closely the punch with the work. Blades have four cutting edges, and are made of tool steel of plain shapes for the purpose of lowering the cost of renewal. The changing of blades, when necessary, is easily and quickly done. The gearing is of steel with machine cut teeth. All shaft bearings are bronze bushed.

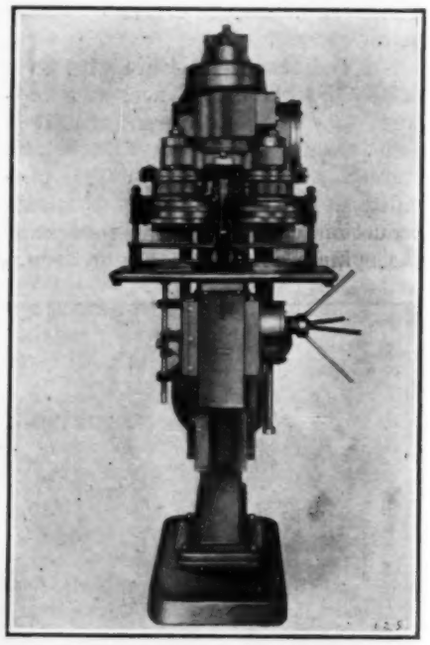
Sizes with capacity for punching $\frac{3}{4}$-in. round holes through $\frac{3}{4}$-in. material, up to $1\frac{1}{2}$-in. holes through 1-in. material, with the shearing in proportion, will be manufactured.



Long & Allstatter No. 2 Combination Shear and Punch

Buhr "Multi-Head" Drilling Machine

The J. F. Buhr Machine Tool Co., Roosevelt Square at 14th and Dalzelle, Detroit, Mich., has recently placed on the market a drill press to be known as the "Multi-Head." It was designed for the drilling of stove burners but can be used for other kinds of work.



Buhr "Multi-Head" Press

The machine illustrated is equipped with two multiple heads. A single head can be used if desired. Ball bearings are provided throughout, and the machine can be furnished semi or fully automatic, with belt, gear or motor drive.

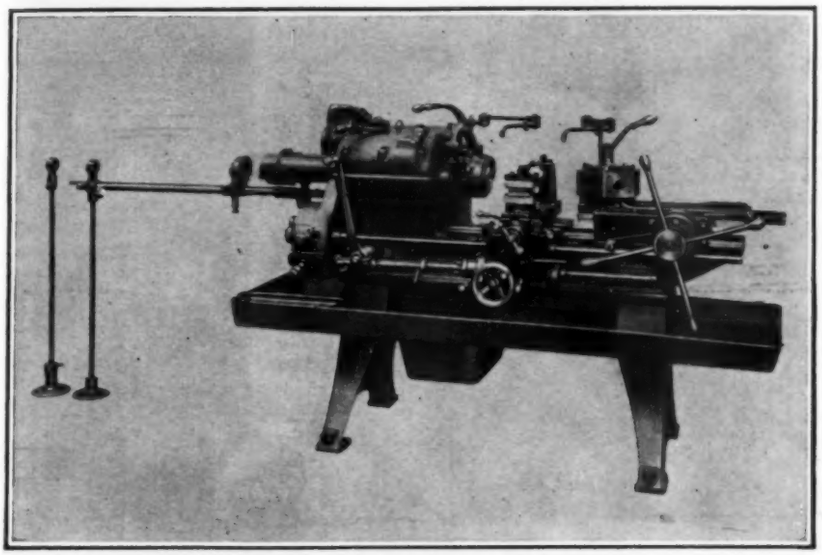
The machine has a flexible feed mechanism through loose change gears, giving feeds from 0.0009 to 0.016 in. per revolution of the spindle. Spindle speeds up to 2,500 r.p.m. may be used when necessary.

The maker states that the heads are made interchangeable and that any head can be attached in thirty minutes.

Warner & Swasey "All-Geared Head" No. 4 Universal Turret Lathe

The all-geared head turret lathe, illustrated, is a late product of the Warner & Swasey Co., Cleveland, Ohio.

The machine is motor driven. The motor is mounted at the rear on the head-end leg, and drives a single pulley by means of a belt. A cone pulley can be substituted for the single pulley if desired. Where it is necessary to conserve floor space, the motor can be mounted on the head of the machine.



Warner & Swasey No. 4 Universal Turret Lathe

The machine is claimed to be rapid in operation, easily operated and quickly tooled, making it suitable for small as well as large quantity production. The tooling is easily adjusted and the twelve spindle speeds provide the proper surface speeds for work of various diameters.

Round bars up to 1½-in. diameter can be held in the automatic chuck. For chucking work, a geared scroll-chuck is provided. The maximum swing over the ways is 16 in. and over the cross-slide 8½ inches.

More than seventy-five standard small tools can be furnished for the machine from stock. These tools provide for a wide range of both bar and chucking work.

The standard cross-slide has five cutter positions, four on the square turret and one on the rear toolpost. Cutters in these positions often operate simultaneously with the tools in the hexagon turret. A distinctive feautre of the machine is the two tool-carrying units, each having an independent feed.

The longitudinal feed is disengaged by six independent, adjustable stops carried on a stop roll. The carriage feed is reversed by means of a sliding worm, permitting it to be fed in either direction. The cross-slide is operated by a ball handle and screw, fitted with a large micrometer dial and adjustable indicators for gaging the depth of cut.

The turret feeds are engaged and disengaged by a friction clutch. Eight changes of feed are obtainable through the gear box. The feeds are automatically tripped by independent, adjustable stops, which operate automatically for each position of the turret.

The regular equipment includes: Automatic chuck and bar feed, with master collet and one set of round bushings; front and rear toolposts; square-turret toolpost; oil pan and pump; double friction countershaft.

Taper and chasing attachments are furnished as extras.

The machine weighs 2,450 lb. net, 2,650 lb. crated and 3,175 lb. boxed for export.

Grip-N-Stik Combination Plier and Wrench

The Grip-N-Stik Co., Dover, Ohio, is putting on the market a combination plier and wrench especially intended for the use of mechanics. It is much thinner and lighter in weight than wrenches of conventional design. The tool is made from three drop forgings accurately machined and case hardened. Its length is 7 in. and its weight 10 ounces.

As a plier, the jaws of this tool are always parallel and they can be easily adjusted to four positions with one hand. To change adjustments, the lever has to be opened to the limit. This makes the jaw free and it can be moved to the desired position with the thumb. To re-engage the jaw, the lever has to be closed.

Combination Plier and Wrench

Using the tool as a wrench, a nut can be gripped by the corners as well as the sides. This makes it possible to work in tight places. Damaged and rounded corners are no obstacles.

The range is from a cotter pin to the nut on a ¾-in. bolt.

Bench Rod-Cutter

The Bench Machine Tool Co., 220 No. 13th St., Philadelphia, have brought out a cutter for cutting off round rods of any unhardened material from ⅛ to ⅜ in. in diameter. The

Bench Rod-Cutter

device is intended to be permanently mounted on a bench and used instead of a hacksaw or screw machine on this class of work.

The device consists of a stationary frame upon which is mounted a lever, the abutting faces of frame and lever carrying hardened alloy steel die plates. Holes of various sizes through the dies allow a rod to be passed through them, the length to be cut off being determined by an adjustable stop.

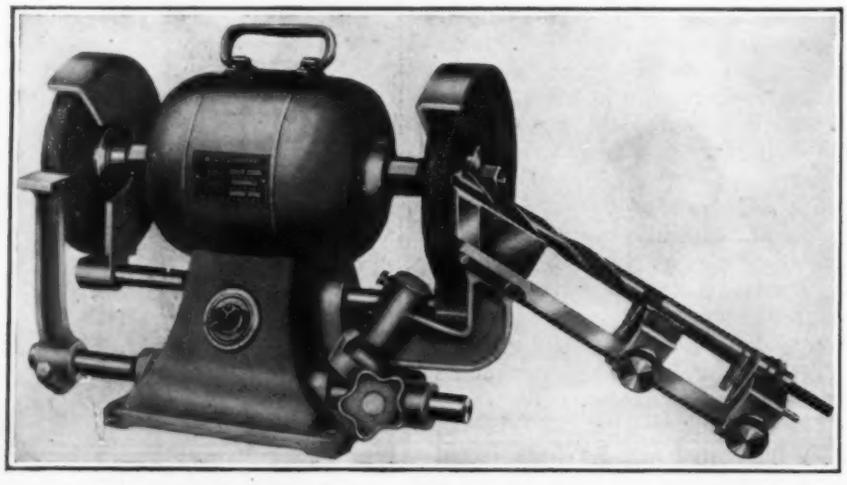
The hub of the hand lever is a segmental pinion meshing with teeth cut upon the end of the main lever. The hand lever is in a nearly vertical position when the holes in the die are in line, so that the effort of the operator may be exerted to greatest advantage. The compounded lever makes the device easy to operate, even upon the largest sizes of material for which it is made.

Black & Decker Twist Drill Grinder

The Black & Decker Manufacturing Co., Towson, Md. has announced an addition to its line of portable electric tools in the form of an electrically-driven bench or pedestal grinder for twist drills.

The machine is primarily intended for small machine shops, garages, service stations and the like which generally depend upon "free-hand" methods of grinding twist drills. The twist drill is fed to the cup grinding wheel by means of a micrometer screw feed, and no adjustments are necessary for grinding different sizes of straight or taper shank twist drills up to ⅝ in. in diameter.

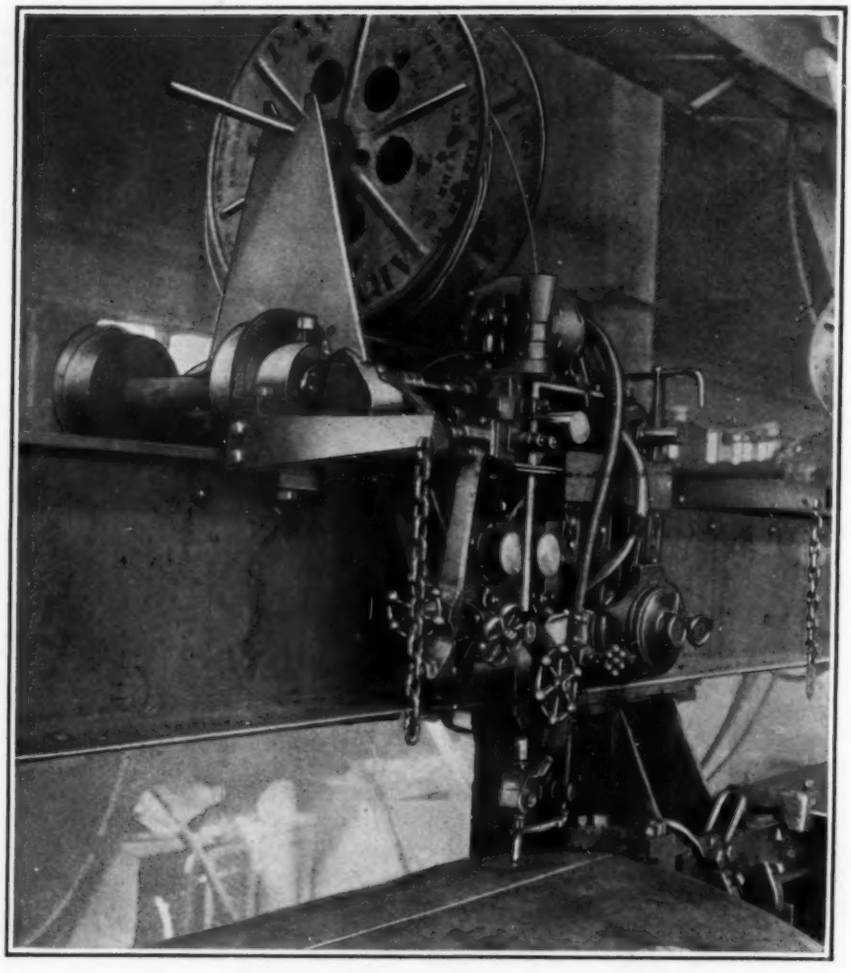
The equipment includes one general purpose grinding wheel, one cup wheel, one tool rest, two wheel guards, electric switch in base and electric cable fitted with attachment plug. It can be plugged into a lamp socket and is ready to run as soon as it is received.



Black & Decker Twist Drill Grinder

G. E. Automatic Arc Welding "Travel" Carriage

The General Electric Co., Schenectady, N. Y., has developed a "travel" carriage for the automatic arc welding of straight seams, the purpose of which is to simplify the welding process in production work where similar welds are made repeatedly upon articles of a simlar nature.



G. E. Automatic Arc Welding "Travel" Carriage

This device forms a self-contained unit consisting of an automatic welding head, necessary control, travel motor and wire reel support, all mounted on a suitable framework and provided with wheels for rolling along a track. The welding head and control are mounted on the apron of the carriage and feed the electrode wire from a reel to the arc. This reel is carried by supports attached to the carriage frame.

The welding head and travel motor are controlled simultaneously and are automatic in their action.

The approximate dimensions are: Length 3 ft. 6 in., width 2 ft. 7 in., height above track 2 ft. 6 in. The weight is 800 pounds.

News of the Week

Excellent Discussions Characterize Annual Meeting of A. S. M. E.

Machine shop practice papers—Col. Dickson's thesis—Farrand, Kimball and Low are banquet speakers—Carnot meeting—Excursions

The forty-fifth annual meeting of the American Society of Mechanical Engineers opened at the Engineering Societies Building in New York on Dec. 1. It lasted until Thursday evening, Dec. 4. Total registration was 22,000.

As the details of the program have been published in previous issues, only those meetings of immediate interest to the machinery industry will be covered. The Machine Shop Practice Division held four sessions; one in conjunction with the Research Committee on Cutting and Forming Metals, another in conjunction with the Special Research Committee on Lubrication, and a third in conjunction with the Management Division.

The Management Division, in addition to its joint session just mentioned, held a joint session with the Taylor Society at which Frederick W. Taylor's paper on "Shop Management," first offered at the spring meeting of 1903 was represented by Morris L. Cooke. The lively discussion brought out the many changes in management ideas that have occurred in the meantime. During this meeting, L. P. Alford, editor, Management and Administration, presented resolutions pointing out the invaluable work done for the society and for the science of management by the late Frank B. Gilbreth. They were passed by a rising vote.

The two papers presented at the joint session of the Machine Shop Practice and Management Divisions were among the best ever offered to the society. R. E. Flanders' paper, "Design, Manufacture and Production Control of a Standard Machine," was published in full in the *American Machinist* for Dec. 4, and Col. George D. Babcock's paper on production control will be published shortly.

Hardness Testers Compared

The Research Committee on the Cutting and Forming of Metals, B. H. Blood, chairman, sponsored a session at which a comparison was made by J. O. Keller of the Pennsylvania State College of the Herbert pendulum and other hardness testers. The Brinnel, scleroscope and Rockwell methods were also discussed and the fields of each considered. A. B. de Forrest of the American Chain Co., told of his work with the magnetic testing of ferrous metals for various qualities.

Professor Boston, of the University of Michigan, described the Vickers hardness-testing machine. The main feature is that the load is applied gradually, taking 20 sec., rests for 10 sec., and is released. The control is automatic. Loads of 10, 50 and 100 kg. are applied according to the piece being tested.

The machineability of metals was discussed from various angles. The point was brought out that this quality depended on what kind of machining was to be done as drilling, threading and turning required a different hardness to secure best results. Joseph K. Wood, chairman of the Research Committee on Metal Springs, presented a brief report outlining the work now being considered. At a simultaneous session papers were presented on "Strength and Proportion of Wheels, Wheel Centers and Hubs," by R. Eksergian of the Baldwin Locomotive Works, "The Turbine Designer's Wind Tunnel," by H. Loring Wirt of the General Electric Co., and the "Test of a Prosser-Type Reciprocating Steam Engine," by L. V. Ludy of Purdue University.

Interesting Papers

The Machine Shop Practice Division with F. O. Hoagland in the chair held a lively session on Tuesday afternoon. "The Effect of Inaccuracy of Spacing on Strength of Gear Teeth," by Lloyd J. Franklin and Chas. H. Smith, both of California, provoked much discussion from gear men who questioned the determinations in view of different types of gears being used for the different tests. The test machine used was also criticised. The paper stated that "gears whose inaccuracies of spacing do not exceed 0.001 in. will carry twice the load of gears having errors of 0.006 in."

"Mechanical Springs," by Joseph K. Wood, treated the subject collectively in the hope of clarifying theories of design and of assisting in the ultimate standardization of springs for various uses.

Herbert B. Lewis of the Brown & Sharpe Manufacturing Co. described a method of ruling line standards free from measurable error by the use of light interference, and the end measuring machines on which the method can be used. This was discussed by several members including Geo. M. Bond, known by many as the "dean of fine measurements," who told of some of the earlier work done along this line.

At the joint Lubrication and Machine Shop Practice Session three good papers were offered: "An Investigation of the Critical Bearing Pressures Causing Rupture in Lubricating-Oil Films," by Lieut. Com. L. N. Linsley, U. S. N.; "High-Pressure Bearing Research," by Louis Illmer; and "A Graphical Study of Journal Lubrication (Part II)," by H. A. S. Howarth. Abstracts of the first two will be published in another issue.

National Defense Session

The National Defense Session, Major Fred J. Miller, chairman, contributed two of the best papers that have been presented in many years. An outline of the program of industrial preparedness was given by Dwight F. Davis, assistant secretary of war, who pointed out the need of preparing capacity for making arms and ammunition rather than the munitions themselves. Mr. Davis ended with the promise that, should another war come, there could be neither slackers nor profiteers, a sentiment that was heartily commended by all. Major J. B. Rose had a paper on "Problems in the Design of Ordinance," with special reference to the 75-mm gun.

Col. T. C. Dickson, commandant, Watertown Arsenal, presented a most interesting paper on "X-Ray Examination of Metals," in which he described the 280,000-volt X-Ray machine installed at Watertown and showed how it was used in detecting flaws in metal up to 3 in. thick. Flaws of various kinds in castings as well as defects in welded joints are shown on X-ray plates in the same way as physicians show defects in the human body, he stated. The possibilities of this method open up fields in which we have previously had to take much on faith, depending entirely on external inspection, Colonel Dickson pointed out. F. C. Langenberg, metallurgist of Watertown Arsenal, also spoke on "New Developments in Gun Construction,"

pointing out methods of increasing the strength of materials that can be applied to other fields as well.

The presidential address and reception held Tuesday evening was the most successful one for many years. Instead of the usual handful of people the auditorium was filled almost to capacity to hear President Low make his farewell address. At its conclusion the report of the tellers of election was presented and President-Elect William F. Durand was escorted to the platform by Dean Dexter S. Kimball and former governor James Hartness. Dr. Low welcomed the new president who responded briefly and received the gavel that is significant of his office. The customary formal reception followed.

The subject of Dr. Low's address was "Power." He said:

Dr. Low's Speech

"It is within only comparatively recent times that the burden of supporting the race, the drudgery of the struggle for existence, has been transferred to power-operated machinery. Up to the Nineteenth Century man was largely dependent upon the work of his own muscles and those of the animals that he had domesticated, for his sustenance, shelter and transportation. His only help from natural resources was in crude adaptations of water and wind power. Today, power-operated machinery is doing in these United States alone more work than could be performed by all the able-bodied men in the world working like slaves from sunrise to sunset.

"The end of the known supply of anthracite is approaching. There are estimated to be, of recoverable fuel of this type in the United States, some eleven billion tons, which at our present rate of consumption will last only about 100 years.

"Of bituminous coal and lignite there are estimated to still be in the United States some 3½ million million tons, of which about 60 per cent would be recoverable by present methods. We have already used 12 billion tons. At our present rate of consumption the rest would last some 4,000 years. But our rate of consumption has been increasing for the past 25 years at a fairly uniform rate of about 18 million tons yearly. If this rate of increase continues so long, we should use up our visible supply in less than 500 years.

Julian D. Sears, of the United States Geological Survey, in a paper to be presented at one of the sessions of the meeting, says that the American petroleum industry began in 1859 and it took over 41 years to produce the first billion barrels. The seventh billion was produced in a little over a year and a half. If what now remains could be continuously extracted and consumed at the 1923 rate, it would last less than 11 years.

"Power is of such vital and increasing importance that its control would give its possessor a mastery over his fellows and opportunities for tyranny and extortion possessed by no autocrat of any previous empire, visible or invisible, feudal or industrial. The people may well be concerned at any gesture in that direction. Happily, their interest in the water powers has been guarded by the Federal Water Power Act of 1920, which maintained in its integrity and faithfully administered, will retain the title of the nation in these resources, under conditions that offer opportunity to initiative, security to capital and freedom from extortion to the consumer. Control over the distribution and sale of power by public utility corporations is in the hands of public service commissions in most of the states. But an uninterrupted and abundant supply of power cannot be assured to the nation at reasonable rates so long as the fuel from which most of it is made is subject to the uncontrolled manipulation of private interest and the organized will—or won't—of labor.

"Recent researches in electrochemistry and molecular physics have been productive of marvelous results and are full of suggestion for future possibilities. The time is not inconceivable when the tools of our present wasteful processes of power generation will be as archaic as the turbine of Hero and the engine of Papin. For the present we must use our best endeavors along established lines to make the most and best efficient use of our diminishing visible resources in the fact of the rapidly growing demand."

The dinner on Wednesday evening at the Hotel Astor was something of an innovation and took the place of the dinner dance and smoker of other years. Nearly 700 members heard Toastmaster C. N. Lauer, general manager, Day & Zimmermann, introduce the three speakers, President Livingston Farrand of Cornell University, Dean Dexter S. Kimball of the same institution, and the retiring president, Fred R. Low, editor of *Power*.

Many Prominent Members

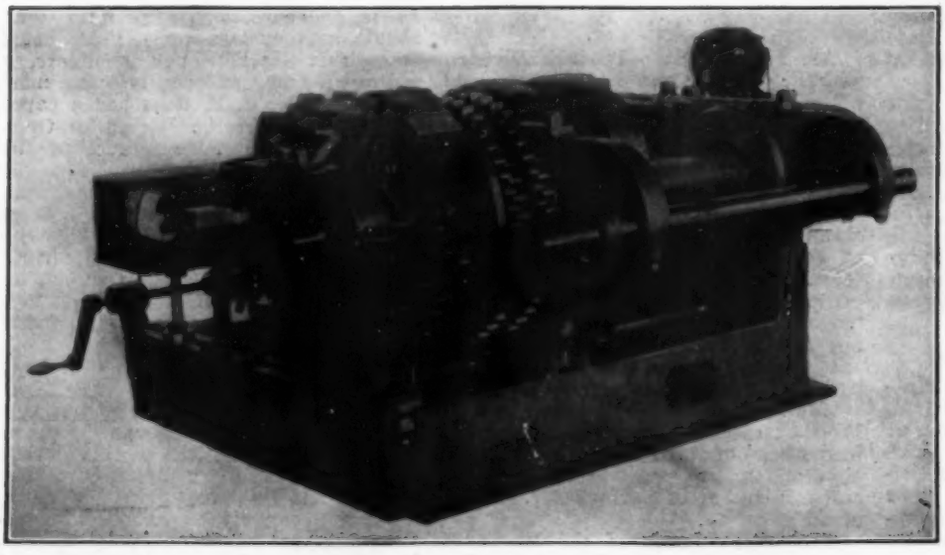
In keeping with the basic idea of the dinner which was to introduce the new members to the society and its work, President Low called on the following members and guests to stand and be presented: Mr. Rand, president of the American Institute of Mining and Metallurgical Engineers; Mr. Osgood, president of the American Institute of Electrical Engineers; former Governor James Hartness, president of the American Engineering Council; past presidents W. R. Warner, Ambrose Swasey, John R. Freeman, W. F. M. Goss, D. S. Jacobus, Fred J. Miller, Charles T. Main, Dexter S. Kimball, John L. Harrington, and the president-elect, Dr. William F. Durand. Mr. Low then called on the vice-presidents, managers and committee chairman.

The secretary, Calvin W. Rice, called the roll of the members admitted since the last annual meeting and each one stood as his name was called. Then the members of 35 years standing or more stood in turn and each gave his name and the year of his admission. The two senior members, both of whom gave the year of their joining as 1880, were Mr. Warner and Mr. Swasey.

Dean Kimball said that the one feature that distinguishes the A.S.M.E. and other engineering societies from the general run of clubs is that the criterion for membership is performance and technical attainment. He went on to say that the membership as a whole gets out of the society no more than it puts in. Most of the members, on the other hand, get out more than they put in because a few put in far more than they get out.

Dr. Farrand said that the only two professions devoted to the discovery of new truths and their application for the benefit of mankind are the medical and engineering professions. According to his observation the country is suffering from the worst reign of prejudice in its history, although beneath it all is an idealism higher than ever. A great responsibility of sane leadership rests on the shoulders of the men who have been trained to think along sound economic lines.

At a general session on Tuesday afternoon, P. W. Bridgman, professor of Physics at Harvard University, lectured on "Properties of Matter Under High Pressure." In the evening at



Lewis Gear Testing Machine

7.30 o'clock, a progress conference of the technical committees was presided over by Dr. Low. Each committee reported the important developments in its field during the year. At 8.15 a "Carnot Centenary" was addressed by Dr. Michael I. Pupin on "Carnot's Principle," and by Dr. William Leroy Emmet on "Carnot's Influence on Engineering."

A feature of the meeting was the Lewis gear-testing machine built at the Bilgram Machine Works, Philadelphia, for the use of the Special Research Committee on Gears, Wilfred Lewis, chairman. The machine, shown in the illustration, had just been completed, so that the tests conducted by Mr. Lewis during the meeting were the first to be made. They indicate that much valuable information will be obtained through its use. It will be sent back to the Bilgram shop for further adjustment and will then go to the Massachusetts Institute of Technology for experimental work.

Enough money has been contributed by machine tool builders, technical periodicals, gear manufacturers and others to cover the first cost of the machine, but additional subscriptions to carry on the work will be welcomed by R. E. Flanders, the Jones & Lamson Machine Co., Springfield, Vt., a member of the committee.

Excursions were made to the Sherman Creek Station of the United Electric Light & Power Co., to the yards of the Long Island R.R. to see the oil-engine driven electric locomotive developed by the General Electric Co., and the Ingersoll-Rand Co., to the Hudson Ave. Station of the Brooklyn-Edison Co., to the Bayway Refinery of the Standard Oil Co., and to the dirigible balloon hangar at Lakehurst to inspect the "Shenandoah" and the "Los Angeles."

Large Increases Shown in Automobile Exports in October

Ten months' total ahead of that of twelve months of 1923

With October exports of automotives valued at more than two and one-half million dollars over the figures of the previous month, ten month totals for 1924 of $185,443,098 were reached, according to the Automotive Division of the Department of Commerce. This total amount is over $15,000,000 better than the valuations of automotive shipments for the full twelve months of 1923. October shipments were valued at $18,775,127 and reflect a marked rise in foreign business.

The five major groups of commodities—passenger cars, trucks and motor cycles from the United States, and passenger cars and trucks from Canada—showed material increase in October as compared with September, and in the case of the first two reached nearly to the peak month of April, this year. Nevertheless, compared with production, October exports of cars and trucks from the United States and Canada combined were under the average for the year to date.

Assembling Abroad

The steadily growing importance of the foreign assemblies of American cars and trucks is shown clearly by the ten months returns. During this period, almost one hundred and twenty thousand cars and trucks have been assembled by American companies in their foreign plants, a striking increase over the figure of 106,110 reported for the entire year 1923. Part of the difference is accounted for by the fact that another large American manufacturer began reporting foreign assemblies from the first of 1924, but this has not materially affected the total figures for the year. However, it will probably make a material difference in next year's figures.

Compared with the 288,008 cars and trucks produced in September, the production in October, 393,149, represents an increase of 37 per cent. Exports of cars and trucks in September were 16,891, and they rose in October to 21,611; with the larger proportional increase in production, however, the percentage of exports decrease.

Annual Conference of Oakite Force

The eighth annual sales conference of the Oakley Chemical Co. was held at the main offices of the company, 22 Thames St., New York, Dec. 1 to 4 inclusive. There was a complete schedule that began at the arrival of the men and ended when the last session was held. No time study man could plan a more complete production schedule.

Short papers and talks were the rule, and every field man gave a two-minute talk. The technical papers were short with discussions limited to 15 minutes. The technical papers were: "Metal Cleaning," by O. W. Hoster; "Oakite Materials and Methods in Automobile Factories," by J. A. Maguire; "Oakite Materials and Methods in Railroad Shops," by R. E. Powell; and "Tanks and Heating Equipment," by H. Harrison.

An enjoyable dinner was held at Hotel Pennsylvania on the evening of Dec. 2, followed by a theater party. There was also a banquet on Dec. 3 at which C. F. Radley was toastmaster.

Sales problems were discussed on Dec. 3 and 4, David S. Ball, Fred A. Aston, A. L. Conant, C. E. Barber and sales manager J. F. Tonn taking the leading parts.

There was an abundance of enthusiasm in evidence at all the sessions and the discussions showed keen interest and study on the part of the salesmen. The value of these conferences was well shown by the zest displayed by the men.

Power Show Proves Interesting

The third national exposition of Power and Mechanical Engineering was held at Grand Central Palace, New York, Dec. 1 to 6 inclusive. The exhibits this year required three floors and included an increasing number of exhibits of machinery and machine accessories, such as dial gages, taps, mandrels and the like. The number of exhibitors increased from 260 to 370.

The exhibits were attractive and held the attention of visitors, many of whom were from out of town and were also attending the A. S. M. E. convention. The attendance exceeded all previous records.

The dramatic evolution of American industry was graphically portrayed in a series of industrial exhibits displayed under the auspices of the National Museum of Engineering and Industry, as a feature of the annual Power Show now in progress.

The Exhibits

Many of the exhibits were furnished by leading American corporations, including the United States Steel Corp., the Bethlehem Steel Corp., the Westinghouse Electric & Manufacturing Co., the Western Electric Co., the Edison Co. and the New York Central R.R., while the U. S. Smithsonian Institution, Columbia University and the national industrial associations co-operated by furnishing others.

The exhibit was designed by the National Museum of Engineering and Industry to illustrate in a limited measure the educational value as well as the dramatic interest that attaches to the preserved record of industrial evolution; and is a step in the nationwide movement to create a great public endowment of $10,000,000 to erect a mammouth national industrial museum at Washington, with branch museums of industry and engineering located in the industrial centers throughout the country.

Industrial Engineers Hold Election

At the annual meeting of the Society of Industrial Engineers held recently in Chicago the following officers were elected:

W. G. Sheehan, president of the Crystal Corp., Detroit, president; Edward T. Miller, executive secretary of the United Typothetæ of America, treasurer; George C. Dent, Chicago, executive secretary; Eugene A. Rummler of Rummler & Rummler, Chicago, vice-president in charge of promotion; Prof. Walter F. Rittman, Carnegie Institute of Technology, Pittsburgh, vice-president in charge of education. The following were elected directors to fill vacancies; Louis B. Dorr, the Dold Packing Co., Buffalo, and Prof. George H. Shepard, Purdue University, La-Fayette, Ind.

It was decided to hold the next convention at Cleveland on May 6, 7 and 8. The headquarters will be the Hotel Winton.

The Business Barometer

This week's outlet in Commerce, Finance, Agriculture and Industry based on current developments

By Theodore H. Price
Editor, *Commerce and Finance, New York*

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SCIENTISTS describe the energizing impulse that proceeds from radium as its "emanation," and it is not too much to say that the whole of business America is today affected by the "emanations" of the New York Stock Exchange. They are invisible waves. Men are sometimes unconscious of their influence, but their effect is none the less palpable and the whole economic structure is now swaying to their rhythm.

Early in the week there were some indications of a reaction in the security market, but on Wednesday the President's message gave the signal for a fresh advance, and as the week closes eveything is *coleur de rose* again. No one denies that the speculative enthusiasm will exhaust itself in time, but it is idle to predict when the end will come, and all that the conscientious interpreter of events should or can do is to point the things that suggest caution at a time when optimism is supreme.

But if "words are things" there is no gainsaying the constructive value of the President's message. Its epigrammatic quality is not the least of its merits, but its insistence upon the need for economy, lower taxes, and railroad consolidation was most reassuring. The result was an immediate rise in the security market, especially in the railroad shares, concerning whose future the most extravagant predictions are now to be heard.

But it must be admitted that the distributive trade of the country is showing definite improvement. The Western mail order houses report a big increase in sales for November. The chain stores tell the same story.

In the dry goods market there is more inquiry for cotton fabrics, and raw cotton itself has shown great resistance despite the larger crop estimates that are in circulation. Lumber is also moving more freely, and a somewhat stronger market for hides and leather is reported. Sugar is likewise impressively steady when the large crop in prospect is considered, and corn, wheat, rye and oats have shown no real weakness, although they are not higher than they were. Oil and gasoline are also higher upon statistics that indicate decreased production, and coffee is about the only commodity that has developed any real weakness.

The outlook, in fact, is so cheerful that those who even hint that it may change are in danger of being called "killjoys," and among all the commentators upon the situation the National City Bank is the only one that sees a cloud even as large as a man's hand. This cloud is the possibility of higher money, that always operates as a check upon speculation. In its monthly review the Bank points out that but little of the huge supply of available credit is actually idle, and that much of it is now tied up in assets that cannot be promptly liquidated.

In support of this view it is pointed out that whereas the loans and investments of the reporting member banks of the Federal Reserve System were but $16,419,000,000 on Nov. 14, 1923, they were $18,431,000,000 on Nov. 12, 1924, and that of this increase of $2,012,000,000, or 12½ per cent, only $204,000,000 was in loans classed as commercial, whereas loans against securities gained $738,000,000 and investments by the banks on their own account increased $1,070,000,000.

Attention is also called to the fact that most of this increase has taken place during the last five months, as loans gained by $930,000,000 and investments by $840,000,000 between June 2, 1924 and Nov. 12, 1924.

In presenting these figures the review adds that "it is evident that the expansion of banking credit in the last year has been almost wholly outside the regular commercial banking field" and that "more than one-half of the bank deposits of the country are now employed for other than strictly banking purposes."

Discussing the subject further the review says in effect that, while it is not intended to suggest that these loans and investments have been imprudently made, it is obvious that they are more or less permanent rather than liquid and that the credit they employ cannot be readily shifted to commercial use. For these reasons it is argued that "an increase in the commercial demand for money or a loss of reserves through a movement of gold to Europe would be likely to effect a rapid change in this cheap money situation."

Meantime a new foreign loan is reported almost daily. Secretary Mellon has sold $200,000,000 30-year 4 per cent bonds, which were several times oversubscribed. The President estimates the Treasury surplus for this year at $67,000,000, and for the year ending June 30, 1926 at $373,000,000. Bank clearings continue to run well ahead of 1923, and railroad earnings are so satisfactory that many dividends are being resumed or increased.

It is estimated that there are now 18,000,000 persons in the United States who own one or more bonds, and the Savings Banks Division of the American Bankers Association claims that there has been an increase of 148 per cent in savings bank deposits during the last ten years. Even our rigid immigration laws cannot keep people out of the country so favored, for in a speech delivered in South America the Secretary of Labor, Mr. Davis, estimates that 175,000 foreigners got in "illicitly" last year.

What's Doing in Industry

Signs of expansion are evidenced in nearly all lines of business where machinery and machine tools are used. The steel companies report greater activity due to railroad and general industrial buying. The automobile companies are planning for higher production after the first of the year and some say that the schedules call for the greatest production in the history of the industry. The big electric companies are planning campaigns for better business in the United States and foreign countries, while electrical goods makers, automobile accessory makers and other buyers of machine tools are either doing more already or planning on improvement.

Inquiries are being received by machine tool dealers in all parts of the country and actual sales are better for this time of the year than had been anticipated. December with its holidays, inventories and used-up budget appropriations has never been considered a lively month.

Rail and industrial shares are still climbing in Wall Street, but without significance as heavy trading among speculators is admitted. Caution is the keynote sent forth by all banks in their monthly statements, but it is doubtful that it will be heeded.

The Industrial Review

Progress of the machinery and machine-tool business in various parts of the country

THE following reports, gathered from the various machinery and machine-tool centers of the country, indicate the trend of business in these industries and what may be expected from the future:

New York

Sales of single tools were reported in the New York market this week and a satisfactory number of inquiries were received, but otherwise the market was dull and without feature. The New York Central and the Central Railroad of New Jersey both closed on several tools for which they had inquired during the past month. A list was received from the Lehigh Valley Railroad Co. and it is expected that there will be some closing on this before the first of the year as most of the items were necessities and for immediate delivery.

Dealers in used machinery are not finding a ready market, although they are having no difficulty in picking up bargains in the various shops due to recent replacements. Most of the dealers are working up through New England with their offerings and a few are still circularizing the South.

There has also been a slowing down of exporting which is seasonal and discounted as such.

Production in other lines of manufacturing and the number of inquiries being received strengthen the belief that January and February will both be excellent months.

Philadelphia

The business situation in Philadelphia continued to show hopeful signs throughout the week. Industrial firms which are ordinarily purchasers of machinery equipment under favorable conditions such as now exist, continued to hold back from any large expenditures because of the approach of the end of the year, when inventories are in order.

No large scale buying on the part of railroads has yet been indicated, although some deliveries have been made. Supplies of rods and some tools are moving much better now than they did a month ago. Public utilities have been purchasers.

That the basic economic conditions are favorable to an early resumption of larger scale business is indicated by the Federal Reserve Bank of Philadelphia. The best evidence of the approach of a revival of business is the increase of more than $9,000,000 of Federal Reserve notes in circulation. This not only indicated greater demand for currency in early holiday buying, but also indicated increased payrolls.

The total amount in circulation is less than the amount of the corresponding week of last year, but the gain was the largest of any one week since early this year.

An analysis of questionnaires returned to the Federal Reserve Bank from five steel foundries discloses that production, shipments and stock improved in October over the preceding month to a considerable extent. The most noteworthy gain occurred in the tonnage of unfilled orders which increased in October 108.5 per cent over September. Value of shipments was $478,867, compared to $281,782, a gain of 69.3 per cent.

Detroit

While machinery and machine tool men in Detroit are finding a larger portion of their sales composed of orders for machine shop equipment and die room equipment for local plants than for special machinery and new devices, the general trend of industry towards expansion has led to an underlying belief that the next few months will be materially better than the latter half of 1924.

Continued predictions on the part of motor executives that 1925 will witness great production has been reflected among the machine tool dealers, and a greater zeal to land the orders that must accompany such expansion is noted in local circles.

December will find many of the plants taking their annual inventories, and production will decrease somewhat. By Jan. 1 most of the plants will again be in full operation, and there is everywhere manifest an optimistic outlook for the new year. Price reductions by Dodge, Hudson-Essex and by Ford within the past two weeks is but an evidence of the competition among motor plants for the business.

New England

The automatic machine business placed in the New England district during the past week was of considerable volume. This was found not only in the business done, but also in the volume of inquiries. In the placing of orders, however the number specifying deliveries "immediately after Jan. 1" was commented upon by machine tool men. The inquiry volume was so much improved and the tenor of the communications was such that consensus among manufacturers is that the first-of-the-year business will be of big proportions and every indication points to overtime operations in the course of the next four or five weeks.

There was an improvement in immediate delivery business among the small tool builders. Production is now heavier in volume by reason of increased working forces and extended working schedules. In this line, too, reports were received that the prospective business is good.

In general the machine tool builders have made effective the policy of discontinuing operations on stock productions to keep the inventories down. Buying is done only where it is necessary.

Machinery operations improved in many localities. A Connecticut subsidiary of a Western motors organization is employing machinists and in three weeks has added about 200 to its payroll and has increased working hours from 45 to 55 hours weekly. In a neighboring city metal industries have recently added 200 to the working forces. Still another industry has advertised for machinists and has increased its working hours.

Cleveland

Usual last month slackening in machine tool demand in the Cleveland territory has made its appearance, and from now until the end of the year little change in the situation is expected by manufacturers or distributors. However, the steady improvement in outlet and the greater improvement in inquiry for all descriptions of equipment during November gives rise to the belief that the turn of the year will bring a marked increase in new business. It is toward this change for the better that plants in this district are shaping their course.

The most encouraging phase to date is the greater variety of outlet for machine tool equipment, both heavy duty and light. For example, the shear, punch and similar equipment have been finding the way into consuming channels largely in the structural steel field. Recently, leaders in this division assert, a more varied assortment of orders has been coming in and from a wider territory, indicating that the improvement in demand for general manufacturing also is being felt outside of the immediate Cleveland district. In this respect, November showed a significant gain over October and preceding months.

In the planer and allied lines, that have heretofore held the forefront of activity when other lines were distinctly dull, this improvement is not reflected during the last week or so. Certain interests which have, for several months, found themselves nicely ahead in orders and somewhat behind in delivery, now have finally caught up with these and are now in the market for new business. At the same time more inquiry has developed in the last two weeks in these fields than has come forward in a similar period for a long time. The usual inventory period is offered as the reason for holding these prospective orders in abeyance, and here also the turn of the year is expected to bring a realization on this preliminary effort.

The best barometer for the movement, however, is the automatic trade, and here a good deal of satisfaction is expressed over the wide variety of inquiry that has developed in the last few weeks. Not a little of this inquiry has come from sources that were distinctly dormant during the greater part of the year, holders of these inquiries point out. Little of this business is expected to be booked during December, but immediately after the first of the year the manufacturers who have made these inquiries for new equipment assert they will be in the market definitely. This will mean that this branch of the industry will not have to depend entirely upon the automotive and allied fields for its principal outlet during the late winter and early spring.

Cincinnati

Executives in the machine tool industry in Cincinnati feel encouraged at the outlook for business. Even though the Christmas holiday season is close at hand, volume of production in the past month has been satisfactory and orders have been coming in well. There is almost always a conservative spirit shown as the end of the year approaches and 1924 will be no different from past years in this respect. As the inventory period draws near less buying is noticed, but despite this fact, manufacturers are getting business in sufficient volume to keep their plants operating on a scale equal to that which prevailed during October and November.

An optimistic event of the past week was the announcement that the Chevrolet plant in Norwood, a suburb of Cincinnati, would resume normal operations at once. This branch has been idle for several months and the resumption of activities lends a feeling of good cheer to the local industrial market.

Inquiry among some of the Cincinnati companies shows that foreign trade is slightly better than it has been. While the export business does not begin to compare with former days, orders to a limited extent are being placed and local executives believe that the day is not far distant when the export trade will again become of considerable importance.

The large manufacturing concerns state that their November production was on a par with that of the previous month and in some cases the books revealed an increase over October. In fact comparison with the volume of production during the corresponding period of 1923 brings out the fact that in a number of instances this year's operations are in excess of those of last year.

Lathes and milling machines are being turned out at a normal rate at present. Planers are having a fair sale, while specially designed machinery has the call in many plants. Drilling machine manufacturers say that the market is rather spotty. There have been no outstanding orders placed for electrical tools, but production is going ahead in a satisfactory manner.

Foundries report that their operations have been fair with business falling off slightly in the last week. The used machinery market is firm with good business being placed.

Business Items

The Piston Ring Co., Muskegon, Mich., and the No-Leak-O Piston Ring Co., Muskegon, Mich., have consolidated and will henceforth be known as the Piston Ring. Co.

The N. C. Failor Co., 30 Church St., New York City, has been appointed sales representative in the New York district for the Stockbridge Machine Co., Worcester, Mass.

Charles Bond & Co., Philadelphia, have been appointed distributors for the Foote Bros. Gear & Machine Co., Chicago, Ill., in the eastern Pennsylvania, Maryland, Delaware and part of New Jersey districts.

The plant of I. M. Smith & Son, of Marcellus, Mich., manufacturers of motor truck cab bodies, which was destroyed by fire recently, will be rebuilt at once, officials state.

The Model Body Corp., 7201 East Six-Mile Road, Detroit, has been reorganized and additional capital put into the business for expansion. The production of passenger car bodies will be continued, but in the future the company will also specialize in bus and commercial bodies. Walter F. Thompson has been elected president and general manager of the company to succeed G. L. Gast, who becomes vice-president. George Mercer and C. Lester French continue as secretary and treasurer respectively.

Obituaries

EUGENE A. EDDY, owner of the Eddy Machine Co., Providence, R. I., died recently at the Jane Brown Memorial Hospital, Providence.

MONROE PATTERSON, aged 72 years, died recently in East Liverpool, Ohio. He was secretary and treasurer of the Patterson Foundry & Machine Co.

JOHN L. HARPER, vice-president and chief engineer of the Niagara Falls Power Co., died in that city recently after an operation. Mr. Harper, who was 51 years old, had been associated with Niagara Falls power developments since 1902 and was a recognized authority on hydroelectric engineering.

Personals

E. E. BLUNDELL, formerly factory manager of the Cleveland Automatic Machine Co., Cleveland, Ohio, is now in a similar position with the Lees-Bradner Co., Cleveland.

P. BLAIR LEE, who has been engaged in special work for the vice-president and general manager of the Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa., has been appointed works manager of the company.

A. L. ABRAHAMS, formerly with the Hale & Kilburn Corp., Philadelphia, has been added to the organization of the Kny-Sheerer Corp., New York City. Mr. Abraham will be the factory manager of the concern.

GILBERT MURRAY has resigned as factory superintendent of the Anderson Foundry & Machine Co., Anderson, Ind.

J. E. OTTERSON, formerly president of the Winchester Repeating Arms Co., New Haven, Conn., has joined the International Western Electric Co., New York.

E. F. CREAGER, works manager of the Hill Pump & Turbine Works, Anderson, Ind., has resigned.

BENJAMIN P. LANE has been appointed manager of the newly opened branch of the Sullivan Machinery Co., Chicago, in Los Angeles, Calif. The office and warehouse are located at 412 East Third St.

STODDARD B. MARTIN, formerly with the National Acme Co., Windsor, Vt., is now Cleveland representative of the Cone Automatic Machine Co., Windsor, Vt. His headquarters are at 1899 East 82nd St., Cleveland, Ohio.

H. A. GARVEY has been named carriage division manager of the Packard Motor Car Co., Detroit.

FRANK L. ATWOOD has resigned as general manager of the Hill Pump & Turbine Works, Anderson, Ind.

J. E. LOCHER, manager of the carriage division of the Packard Motor Car Co., Detroit, has been promoted to the position of general factory manager.

ALEX C. HUMPHREYS, D. H. KELLY, WALTER M. MCFARLAND, C. D. R. MEIER, WORCESTER K. WARNER, F. W. LOVEJOY and HENRY R. GILSON have been elected members of the council of the Institute of Weights and Measures.

E. C. LUTZ is now superintendent of the tractor works of the International Harvester Co., Chicago, Ill.

FORREST T. ELLIS, formerly superintendent of tools and equipment of the Cadillac Motor Car Co., Detroit, has been appointed superintendent of manufacturing. He is succeeded in his former position by Victor A. Olsen, who was assistant in the same department.

O. C. ROACH has been elected secretary of the American Manufacturers' Association succeeding Harry W. Hansen, resigned.

A. G. BRICE, formerly machinery buyer for the Packard Motor Car Co., Detroit, has been appointed Detroit manager of the Whitney Manufacturing Co., Hartford, Conn.

LAWRENCE W. WALLACE of Washington, executive secretary of the American Engineering Council, is making a month's speaking tour of the South and West. Addressing local engineering societies in many cities, Mr. Wallace will interpret the aims of the Council, stressing the movement to establish a National Department of Public Works.

J. R. EMERSON, for the past two years connected with the Durant Corp. as purchasing agent at Muncie, Ind., and the Locomobile Co. at Bridgeport, Conn., has resigned, effective Jan. 1, and will return to Detroit to take up sales work.

R. A. MITCHELL, formerly assistant manager of the Chicago office of the R. & J. Dick Co., Inc., Passaic, N. J., has been made manager of the San Francisco, Calif., office.

F. W. GLAUSER, formerly with the Mid-Continent Equipment & Machinery Co., St. Louis, Mo., is now manager of the equipment department in the Southern district for the Hyman-Michaels Co., Chicago. His headquarters are in St. Louis, Mo.

G. A. PABST has been appointed Chicago sales representative for the Stockbridge Machine Co., Worcester, Mass. His headquarters will be at 106 S. Jefferson St., Chicago.

C. E. WILSON, formerly factory manager of the Remy Electric Division of the General Motors Corp., Anderson, Ind., has been promoted to the position of assistant general manager.

R. N. BROWN, former assistant to the factory manager of the Packard Motor Car Co., Detroit, has been appointed general superintendent of the company.

J. C. BATES has been appointed general manager of the Union Tool Co., of Orange, Mass., to fill the vacancy caused by the recent death of Emory E. Ellis, and has already assumed his duties. Mr. Bates was formerly at the head of the Bates Manufacturing Co. of Fitchburg, that was taken over several years ago by the Union Tool Co.

FENTON W. ARMSTRONG, purchasing agent of the Remy Electric Works, Anderson, Ind., has been made factory manager.

GEORGE B. DANIELS has been appointed vice-president and general manager of the Locomobile Co. of America, Bridgeport, Conn., succeeding Edwin B. Jackson, resigned.

ROBT. R. KEITH, formerly superintendent of the tractor works of the International Harvester Co., Chicago, Ill., is now chief of engineering in the motor truck division.

CHARLES GOULD has been appointed director of sales, service and advertising of the Gray Motor Corp., Detroit. He succeeds L. R. Martell, resigned.

E. G. JONES has been appointed general superintendent of the sheet steel and galvanizing unit of the Dominion Alloy Steel Corp., Sarnia, Ontario. Mr. Jones has for the past sixteen years been general superintendent of the Sparrow Point, Md., sheet steel mill.

E. PHIL MERRILL, for 13 years in charge of Cadillac educational work, specializing on the design and construction of the Cadallic chassis, and HENRY H. BATCHELLER, for some time past sales manager for a Boston distributor, have been added to the executive staff of the sales department of the Cadillac Motor Car Co.

What the Railroads Are Doing

Operating revenues of Class I railroads having a total mileage of 236,172 miles amounted to $572,600,000 in October, according to reports for the month compiled by the Bureau of Railway Economics from returns filed by the carriers with the Interstate Commerce Commission. This was a decrease of $15,314,000, or 2.6 per cent under the same month last year.

Operating expenses totaled $403,663,800, a reduction of $41,676,650 or 9.4 per cent under those for October, 1923.

Henry Ford is building the largest and most powerful electric locomotive in the world. It will be used on the Detroit & Ironton Railway, the latest addition to his railway interests, and operating in conjunction with the Detroit, Toledo & Ironton Railroad.

This super-engine, now under construction in the power house at Highland Park plant of the Ford Motor Co., represents an important development in locomotive construction, embodying many new ideas in mechanical design, it is said.

It will weigh 340 tons, will be 117 ft. long, 15 ft. high and 10 ft. wide, and will have 16,250 hp. motors connected to 16 pairs of driving wheels. It is designed to haul a train of 150 or more loaded box cars. Being designed for freight service exclusively it will have a maximum speed of 35 miles an hour while running speed will be only 17 miles an hour.

The Illinois Central R.R. within the past 30 days has ordered new equipment costing $25,515,870.

Orders include 215 steel suburban cars equipped for electrical operation, $8,250,000; 4,000 50-ton composite gondola cars, $8,112,000; 2,000 40-ton composite box cars, $4,460,000; 25 mountain type locomotives, $1,691,375; 200 express refrigerator cars, $917,600; 36 passenger train cars, $897,145; 30 coaches, $786,750, and 200 steel underframe stock cars, $401,000.

One of the largest orders for rails that has been placed in the market in recent months will be given out shortly by the Pennsylvania System to supply a part of its needs for 1925. Although the exact amount of the order has not been determined it will be in the neighborhood of 100,000 tons.

Several large orders for railroad equipment, rails and other steel material aggregating $2,500,000, were filed recently.

The American Locomotive Co. received an order from the Louisville & Nashville R.R. for eight Mikado type locomotives and eight eight-wheel switching locomotives.

The Southern Pacific Co. ordered 22,500 tons of steel rails.

Fifty locomotive tenders were ordered by the New York Central. Thirty-five of these will be manufactured by the American Locomotive Co. and fifteen by the Lima Locomotive Works.

The American Bridge Co., a subsidiary of the United States Steel Corp. received an order for 10,000 tons of structural steel from the Bell Telephone Co. of Ohio.

An application has been filed with the Interstate Commerce Commission by the New Orleans, Texas & Mexico Railway Co. for authority to issue equipment trust certificates to the extent of $1,740,000 to be applied on the purchase of the following equipment: 500 forty-ton steel underframe box cars; 500 cars for automobiles; 250 gondola cars and 2 steel dining cars.

The New York Central system has placed orders for 3,000 steel box cars. The orders were distribuited as follows: One thousand from the American Car and Foundry Co. at St. Louis, for the Big Four; 1,000 from the Standard Steel Car Co. at Hammond, Ind., for the Michigan Central; 500 from the Pressed Steel Car Co. at Hegewisch, Ill., for the New York Central, and 500 from the Merchants' Dispatch at East Rochester, N. Y., for the New York Central.

Another large order was that of the Texas Co. for 1,000 tank cars. Construction on these cars will be started within two months by the Pennsylvania Car Co.

Export Opportunities

The Bureau of Foreign and Domestic Commerce, Department of Commerce, Washington, D. C., has inquiries for the agencies of machinery and machine tools. Any information desired regarding these opportunities can be secured from the above address by referring to the number following each item.

Screws, bolts and nuts. Valetta, Maltese Island. Purchase. Reference No. 12,478.

Industrial machinery and machine tools. Prague, Czechoslovakia. Agency. Reference No. 12,446.

Industrial machinery and accessories. Helsingfors, Finland. Agency. Reference No. 12,443.

Machinery and machine tools. Warsaw, Poland. Purchase and agency. Reference No. 12,442.

Machinery and machine tools, especially for mines and railroad plants. Hirschberg, Germany. Purchase. Reference No. 12,441.

Railway maintenance machinery. Prague, Czechoslovakia. Agency. Reference No. 12,439.

Forthcoming Meetings

Exposition of Invention. Engineering Societies Building, 29 West 39th St., New York City. Dec. 8 to 13 inc., General offices, 47 West 34th St., New York City.

American Association for the Advancement of Science. Meeting at Washington, D. C., Dec. 29, Jan. 1, 2 and 3. Burton Livingston, Smithsonian Institute, Washington, D. C.

American Society for Steel Treating. Winter Sectional Meeting under the auspices of the Cincinnati chapter. Thursday and Friday, Jan. 15 and 16, in Cincinnati.

Society of Automotive Engineers. Annual Meeting. Detroit, Mich., Jan. 20, 21, 22 and 23. C. F. Clarkson, 29 W. 39th St., New York City.

The Society of Industrial Engineers. National Convention. Hotel Winton, Cleveland, Ohio, May 6, 7 and 8. Executive secretary, George C. Dent, 608 S. Dearborn St., Chicago, Ill.

American Society for Testing Materials. Twenty-eighth annual meeting. Chalfonte-Haddon Hall Hotel, Atlantic City, N. J., June 22, 23, 24, 25 and 26. C. L. Warwick, secretary-treasurer, 1315 Spruce St., Philadelphia, Pa.

National Foreign Trade Council. Annual Convention. Seattle, Wash., June 24, 25 and 26. O. K. Davis, secretary, India House, Hanover Square, New York City.

The Weekly Price Guide

Rise and Fall of the Market

Iron and Steel—Maximum quotation on No. 2 foundry (Southern) pig iron now $20 per ton, against $19.50, last week. Iron and steel production increasing. Present iron output mostly on unfilled orders as buying movement has subsided. Cold finished steel is up $2 per ton at mills. Mild steel bars are $2.10 per 100 lb., f.o.b. Pittsburgh mills. Shapes sell at $2@$2.10 and plates, $1.80@$2 per 100 lb., Pittsburgh. Shapes are about 15c. per 100 lb. higher than a week ago. One year ago structurals were $2.40@$2.50 and bars, $2.40 per 100 lb., Pittsburgh.

Non-Ferrous Metals—Copper rose ¼c. this week, reaching the highest point in thirty days. Tin up ¼c. per lb. since Nov. 29. Zinc is ¼c. per lb. higher than a week ago in New York warehouses. Antimony continues firm. Lead market easier. Fabricated brass and copper up ¼c. per lb.

(All prices as of Dec. 5)

IRON AND STEEL

PIG IRON—Per gross ton, f.o.b.:

CINCINNATI	
No. 2 Southern	$23.05
Northern Basic	22.27
Southern Ohio No. 2	22.27
NEW YORK—Tidewate Delivery	
Southern No. 2 (silicon 2.25@2.75)	28.25
BIRMINGHAM	
No. 2 Foundry	19@20
PHILADELPHIA	
Eastern Pa., No. 2x (silicon 2.25@2.75)	23.00
Virginia No. 2	29.75
Basic	21.75
Grey Forge	21.75
CHICAGO	
No. 2 Foundry local	20.50
No. 2 Foundry, Southern (silicon 2.25@2.75)	25.00
PITTSBURGH, including freight charge from Valley	
No. 2 Foundry	22.77
Basic	22.77
Bessemer	23.77

IRON MACHINERY CASTINGS—Cost in cents per lb. of 100 flywheels, 6-in. face x 24-in. dia., hub not cored, good quality gray iron, weight 275 lb.:

Detroit	4.75
Cleveland	4.75@5.00
Cincinnati	5.00@7.50
New York	5.00@5.50
Chicago	5.25@5.75

SHEETS—Quotations are in cents per pound in various cities from warehouse; also the mill base in large lots.

Blue Annealed	Pittsburgh Mill Base	New York	Cleveland	Chicago
No. 10	2.60@2.70	3.89	3.45	3.80
No. 12	2.70@2.80	3.94	3.50	3.95
No. 14	2.80@2.90	3.99	3.55	4.00
No. 16	3.00@3.10	4.09	3.65	4.10
Black				
Nos. 17 and 21	3.25@3.45	4.40	4.15	4.55
Nos. 22 and 24	3.30@3.50	4.45	4.20	4.55
Nos. 25 and 26	3.35@3.55	4.50	4.25	4.60
No. 28	3.40@3.60	4.60	4.35	4.50
Galvanized				
Nos. 10 and 11	3.50@3.70	4.60	...	4.60
Nos. 12 and 14	3.60@3.80	4.70	....	4.70
Nos. 17 and 21	3.90@4.10	5.00	....	5.00
Nos. 22 and 24	4.05@4.25	5.15	3.00	5.15
No. 26	4.20@4.40	5.30	4.15	5.30
No. 28	4.50@4.70	5.60	5.45	5.50

WROUGHT PIPE (Welded)—Warehouse discounts are as follows:

	New York Black	New York Galv.	Cleveland Black	Cleveland Galv.	Chicago Black	Chicago Galv.
1 to 3 in. steel butt welded	48%	34%	55½%	43½%	56%	43%
2½ to 6 in. steel lap welded	44%	30%	53½%	40½%	53%	40%

Malleable fittings: Classes B and C, banded, from New York stock sell at list plus 4%; class A, plus 23%. Cast iron, standard sizes, 36% off.

Size, Inches	List Price per Foot	Diameters Inches — External	Diameters Inches — Internal	Thickness Inches
1	$0.17	1.315	1.049	.133
1¼	.23	1.66	1.38	.14
1½	.27½	1.9	1.61	.145
2	.37	2.375	2.067	.154
2½	.58½	2.875	2.469	.203
3	.76½	3.5	3.068	.216
3½	.92	4.0	3.548	.226
4	1.09	4.5	4.026	.237
4½	1.27	5.0	4.506	.247
5	1.48	5.563	5.047	.258
6	1.92	6.625	6.065	.28

SEAMLESS STEEL TUBING—Following base discounts are on 20 gauge or .035-in., round, cold-drawn tubing, ½-in. to 1-in., O.D., weighing 0.17 lb. to 0.36 lb. per ft. Cutting charge per 100 cuts, $1.50 to $1.58:

O.D. Inches	List Price per ft.	Differential Discount	O.D. Inches	List Price per ft.	Differential Discount
½	$0.09	50%	⅞	$0.16	35%
⅝	.11	45%	1	.18	31%
¾	.14	40%			

NOTE—The discounts are to be lowered by the following differentials in the case of regular .10-.20 carbon: 25,000 ft. or over, 83; 15,000 to 25,000 ft., 82; 5,000 to 15,000 ft., 81; 1,000 to 5,000 ft., 80; less than 1,000 ft., 79.

MISCELLANEOUS—Warehouse prices in cents per pound in 100-lb. lots:

	New York	Cleveland	Chicago
Open hearth spring steel (base)	4.50	6.00	4.20
Spring steel (light) (base)	7.00	6.00	6.00
Coppered Bessemer rods (base)	6.85	8.00	6.55
Hoop steel	4.49	4.35	4.15
Cold rolled strip steel	7.00	8.25	7.15
Floor plates	5.55	4.60	5.50
Cold drawn shafting or screw	4.05	3.90	3.80
Cold drawn flats, squares	4.55	4.40	4.30
Structural shapes (base)	3.34	3.20	3.10
Soft steel bars (base)	3.24	3.10	3.00
Soft steel bar shapes (base)	3.24	3.11	3.00
Soft steel bands (base)	3.99	3.20	3.65
Tank plates (base)	3.34	3.42½	3.10
Bar iron (2.90@3.00 at mill)	3.24	3.21	3.00
Tool steel	11.00	....	....
Drill rod (from list)	60%	55%	50%

Electric welding wire, New York, 3/32, 8.25c.; ⅛, 7.75c.; 5/32 to 3/16, 7.25c. per lb.

METALS

Current Prices in Cents Per Pound

Copper, electrolytic (up to carlots), New York			14.75
Tin, 5-ton lots, New York			56.00
Lead (up to carlots), St. Louis	8.40@8.70	New York	9.37½
Zinc (up to carlots), St. Louis	7.00@7.02½	New York	7.50

	New York	Cleveland	Chicago
Antimony (Chinese), ton spot	16.00	16.00	.....
Copper sheets, base	21.62½	21.12½@21.62½	23.00
Copper wire, base	19.62½	20.00	21.75
Copper bars, base	20.87½	21.87½	22.50
Copper tubing, base	24.00	24.75	25.75
Brass sheets, base	18.37½	18.50	19.75
Brass tubing, base	22.75	24.00	28.25
Brass rods, base	16.37½	17.62½	17.50
Brass wire, base	18.87½	19.50	20.25

Shop Materials and Supplies

METALS—Continued

	New York	Cleveland	Chicago
Aluminium ingots, 98 to 99%, 1–15 ton lots	27.20	28.00	28.50
Zinc sheets (casks)	11.50	12.00	.....
Solder (½ and ½), (case lots)	40@41	34.00	30.00
Babbitt metal (83% tin)	60.00	65.00	48@52
Babbitt metal (35% tin)	28.00	19.50	23@26
Nickel (ingots) f.o.b. refinery	29.00	.....	.....
Nickel (electrolytic) f.o.b. refinery	33.00	.....	.....
Nickel (F shot) f.o.b. refinery	30.00	.....	.....

SPECIAL NICKEL AND ALLOYS—Price in cents per lb.; f.o.b. Huntington, W. Va.:

Rolled nickel sheet (base)	52.00
Hot rolled rods, Grade "A" (base)	50.00
Cold drawn rods, Grade "A" (base)	58.00
Manganese nickel hot rolled rods "E"—low manganese (base)	54.00
Manganese nickel hot rolled rods "D"—high manganese (base)	57.00

Base price of monel metal in cents per lb., f.o.b. Huntington, W. Va.:

Shot	32.00	Hot rolled rods (base)	40.00
Blocks	32.00	Cold drawn rods (base)	48.00
Ingots	38.00	Hot rolled sheets (base)	42.00

OLD METALS—Dealers' purchasing prices in cents per pound:

	New York	Cleveland	Chicago
Crucible heavy copper	11.50@11.75	11.00	11.00
Copper, heavy, and wire	11.25@11.50	10.75	10.50
Copper, light, and bottoms	10.00@10.25	9.75	9.50
Heavy lead	7.00@7.25	6.75	7.00
Tea lead	6.00@6.25	5.00	5.50
Brass, heavy, yellow	7.25@7.50	7.00	7.00
Brass, heavy, red	9.00@9.25	9.00	8.50
Brass, light	6.25@6.50	6.00	6.00
No. 1 yellow rod turnings	7.75@8.00	7.00	7.00
Zinc	4.00@4.25	3.75	3.50

TIN PLATES—American Charcoal—Bright—Per box.

		New York	Cleveland	Chicago
"AAA" Grade:				
IC,	20x28, 112 sheets	$23.50	$22.85	$21.00
"A" Grade:				
IC,	20x28, 112 sheets	19.00	18.80	17.00
	Coke Plates—Primes, 20x28 in.			
100-lb.,	112 sheets	13.00	13.00	12.75
	Terne Plates—Small lots, 8-lb. Coating			
IC,	14x20	7.25	6.80@6.90	6.50@6.75

MISCELLANEOUS

	New York	Cleveland	Chicago
Cotton waste, white, per lb.	$0.14@0.21	$0.19	$0.14
Cotton waste, colored, per lb.	.09@.14½	.18	.10½
Wiping cloths, 13¼x13¼, per lb	11.00@11.25*	36.00 per M	.16
Wiping cloths, 13¼x20½, per lb.	....	50.00 per M	.16
Sal soda, per 100 lb. keg	2.25	2.25	2.65
Roll sulphur, per 100 lb. keg	3.60	3.25	3.50
Linseed oil, per gal., 5 bbl. lots	1.11	1.15	1.05
Lard cutting oil, 25% lard, per gal.	.55	.50	.32
Machine lubricant, medium-bodied (50 gal. wooden bbl.), per gal.	.29	.35	.21
Belting—Present discounts from list in fair quantities (½ doz. rolls).			
Leather—List price, 24c. per lin. ft. per inch of width for single ply.			
Medium grade	40–2½%	30–10%	30–10%
Heavy grade	30–5%	30%	20–5–2½%
Rubber transmission, 6-in., 6 ply, $1.83 per lin. ft.			
First grade	50%	50–10%	40–10%
Second grade	50–10%	60–5%	60–5%

*White, at washery.

Comparative Warehouse Prices

New York	Unit	Current Price	Four Weeks Ago	One Year Ago
Soft steel bars	per lb.	$0.0324	$0.0324	$0.0354
Cold finished shafting	per lb.	.0405	.0405	.044
Brass rods	per lb	.1637½	.1487½	.155
Solder (½ and ½)	per lb.	.40@.41	.38@.39	.3375
Cotton waste	per lb.	.14@.21	.14@.21	11@14
Washers, cast iron (½ in.)	per 100 lb.	6.50	6.50	6.50
Emery, disks, cloth, No. 1, 6 in. dia.	per 100	3.38	3.38	3.38
Lard cutting oil	per gal.	.55	.55	.55
Machine oil	per gal.	.29	.29	.297
Belting, leather, medium	off list	40–2½%	40–2½%	30–10%
Machine bolts up to 1x30 in.	off list	45%	45%	45%

MISCELLANEOUS—Continued

	New York	Cleveland	Chicago
Abrasive materials—In sheets 9x11 in., No. 1 grade, per ream of 480 sheets:			
Flint paper	$4.86	$5.84	$6.48
Emery paper	10.71	11.00	8.80
Emery cloth	28.00	31.12	29.48
Emery disks, 6 in. dia., No. 1 grade, per 100:			
Paper	1.49	1.24	1.40
Cloth	3.38	2.67	3.20
Fire clay, per 100 lb. bag	.....	.65	.60
Coke, prompt furnace, Connellsville	per net ton		3.25@3.50
Coke, prompt foundry, Connellsville	per net ton		4.75@5.25
White lead, dry or in oil	100 lb. kegs	New York, 15.25	
Red lead, dry	100 lb. kegs	New York, 15.25	
Red lead, in oil	100 lb. kegs	New York, 16.75	

SHOP SUPPLIES

	New York	Cleveland	Chicago
Rivets: Button heads, ½-in., ⅝-in., 1x2-in. to 5-in., per 100 lb.	$5.00	$3.50	$3.50
Cone heads, ditto	5.20	3.60	3.70
Washers, cast iron: ½-in. per 100 lb.	6.50	4.00	3.75
⅝-in., per 100 lb.	5.50	4.00	3.75

Machine bolts, up to 1x30-in., with cold punched and hot-pressed hex. nuts, also button head bolts with hex. nuts are $3.50 per 100 lb. at Cleveland. Tap bolts with hex. heads are $4.65 per 100 lb. at Chicago.

Machine bolts, ¼x1½-in., per 100, $1.70. Discount at New York warehouses on all sizes up to 1x30-in., 45%; 1½ and 1¼x3-in. up to 12-in., 15%; with cold punched hex. nuts up to 1-in. dia. (plus std. extra of 10%) 35%; with hot pressed hex. nuts up to 1x30-in. (plus std. extra of 10%) 40%.

Carriage bolts, ¼x1½-in., per 100, $1.00. Discount on all sizes up to 1x30-in., 35%.

Coach and lag screws, 1½x-$\frac{5}{16}$in., $2.25 per 100, less 45%.

Tap bolts, 1½x½-in., $1.00 per 100. List plus 35%.

Bolt ends, 1x12-in., 10c. per lb., less 45%.

Nuts, semi-finished, ½x½-in., 2c. each. Discount 70% for $\frac{5}{16}$-in. and smaller and 65% for ⅜-in. and larger.
Case hardened, ½x½-in., 6c. each, less 50%.

Rivets, $\frac{7}{16}$x1-in. and longer, 19c. per lb., less 60%. Same discount for tinned EXTRA per 100 lb. for 1½ to 2-in. long, all diameters, 25c.; ⅜-in. dia., 35c.; ½-in. dia., 75c.; 1-in. long and shorter, 75c.; longer than 5-in., 50c.; less than 200 lb., 50c.; countersunk heads, 45c.

Machine Requirements and Industrial Construction

Machine Tools and Equipment Wanted

Ala., Decatur—Holland-Blow Stave Factory—J. N. Gibson, Genl. Mgr.—stave making machinery, boiler and engine for new plant to replace one recently destroyed by fire.

Calif., Los Angeles—Weber Auto & Trailer Wks., 1505 Santa Fe Ave.—Cincinnati milling machine.

D. C., Wash.—Bureau of Supplies & Accounts, Navy Dept.—receiving bids until Dec. 16 planer and shaper delivered to Navy Yard, Boston.

D. C., Wash.—Bureau of Supplies and Accounts, Navy Dept.—receiving bids until Dec. 9, grinding machines and brass and steel pipe delivered to Navy Yard, Boston, Mass.

Ill., Rinard—Rinard Mfg. Co.—two automatic screw machines, one geared punch press, 45-50 ton pressure, 2½ in. stroke, good die spacer, one tumbling barrel, one hardening pot, one lathe (will consider first class used machines).

Ind., Indianapolis—Goldberg Ozone Mach. Co. (generators)—power punch presses and shears, any reliable make and size.

La., New Orleans—Cahn Bros. & Ryder—hand power machine for bending reinforcing bars.

Mass., Boston—P. Cerbone, 159 Everett St.—tools and equipment for repair and service garage.

Mass., Boston—Eastern Showcase Co., 146 Friend St.—horizontal boring machine for light woodwork.

Mass., Boston—Merrimac Oil Burning System, 53 Merrimac St.—2 in. hollow spindle engine lathe, 12 in. swing, short bed with counter shaft check and face plate; upright drill clear—14 to 16 in.

Mass., Brighton—Commonwealth Realty Co., 20 Colon St.—miscellaneous tools and equipment for service garage.

Mass., Cambridge—J. J. Shine, 1374 Massachusetts Ave.—equipment for garage and repair shop on Green St.

Mass., Dorchester—C. M. O'Neill, 19 Corwin St.—general garage equipment and auto repair tools.

Mass., East Boston (Boston P. O.)—M. M. O'Connor, 694 East 5th St.—equipment for repair and service garage.

Mass., Jamaica Plain (Boston P. O.)—Wood Hydraulic Hoist & Body Co., 3371 Washington St.—additional equipment for proposed new plant on Beacon St.

Mass., Lynn—R. T. Pender, 41 Sutton—miscellaneous tools and equipment for repair and service garage.

Mass., New Bedford—School Committee—manual training equipment for new school, County and Morgan Sts.

Mass., Rosendale—F. Westurland, 1540 Centre St.—equipment for service garage.

Mass., Westboro—Bd. of Educ.—manual training equipment, including metal and woodworking machinery for new High School.

Mass., West Duxbury—H. S. Winslow—blacksmith power drill, lever or gear feed.

Mich., Ann Arbor—O. M. Ivey 117 North 1st St., portable grinder-Wodack, preheater, Hank preferred.

Mich., Detroit—Liberty Machine Screw Co., 5680 12th St.—one automatic screw machine (used).

Mich., Port Huron—New Egyptian Portland Cement Co.—conveyors, elevators, etc. for handling cement.

Mo., St. Louis—Atlas Iron Wks., Geraldine and Slevin Aves.—saw to cut and mill structural steel shapes, also are still in market for 5- to 10-ton electric crane with 50-60 ft. span, 3-phase, 60-cycle, 220-volt motor.

N. J., Pearl River—F. L. Holt—routing machine, flexible arm.

N. Y., Buffalo—R. H. Hasley, 72 Moreland Ave.—equipment for auto repair shop.

N. Y., Buffalo—F. Vatta, 65 East Bennett St.—equipment for auto repair shop.

N. Y., New York—Overland Metal Novelty Co., 141 Wooster St.—Brown & Sharpe hand screw machine.

O., Deer Park—Superior Lumber & Millwork Co.—E. F. Eyrick, Pres.—one cut off saw, one sticker, one combination machine.

O., Willard—Bd. Educ., B. Wolfe, Clk.—equipment for manual training department including 2 lathes, 18 in. and saws of all kinds, in proposed high school.

Pa., Connellsville—Hyatt Motor Co., West Main St., J. L. Hyatt, Purch. Agt.—lathe, motor and shop equipment for new garage.

Pa., New Brighton—Townsend Co., (manufacturers of nails, rivets and wire)—two 5 ton electric cranes for new storage building.

Wis., Beaver Dam—F. Zweck, 120 South Spring St.—sheet metal working machinery including benders.

Wis., Milwaukee—Northwestern Malleable Iron Co., 756 Park St.—F. L. Sivyer, Purch. Agt.—monorail crane.

Wis., Milwaukee—Northern Realization Co., 1614 Fratney St.—iron working machinery.

Wis., Prairie du Chien—Prairie Mfg. Co., S. V. Taylor, Purch. Agt.—woodworking machinery.

Wis., Tomahawk—Raymond Lumber Co.—M. Raymond, Purch. Agt.—planing mill machinery to replace that which was recently destroyed by fire.

Ont., Durham—Bell & Erdman—equipment for public garage.

Ont., Holstein—J. F. Machean—general equipment for repair and service garage.

Ont., Kincardine—E. A. Sparling—equipment and tools for garage and repair shop.

Ont., Lucknow—C. S. Durin & Son—equipment and tools for service garage and machine shop.

Ont., Neustadt—C. Reis—miscellaneous tools and equipment for public garage.

Que., Montreal—G. Martel, 5626 Park Ave.—complete machinery and equipment for new automobile repair shop.

Que., Montreal—Superior Bolt & Screw Co., Ltd., c/o Crankshaw & Chevalier, McGee Bldg.—equipment for proposed plant manufacturing bolts, screws, etc., also wire manufacturing and drawing.

Ont., Wingham—C. Lloyd & Son—woodworking machinery.

Ont., Wingham—E. Merkley (garage, etc.)—tool lathe, drill press, air compressor, etc.

England, Bristol—Metal Agencies Co., Ltd., 32 Queen Sq.—malleable iron fittings.

Opportunities for Future Business

Ala., Birmingham—The General Motors Co., Pontiac, Mich., will soon award the contract for the construction of a 200 x 190 ft. renewal plant at 28th St. and 6th Ave., South.

Ala., Eufaula—Eufaula Mill & Lumber Co., J. H. Banks and P. B. Ross owners, plans to rebuild plant recently destroyed by fire.

Ala., Piedmont—The Wiggonton Cooperage Co., Talladega, plans the construction of a new heading mill.

Ala., Decatur—Holland-Blow Stave Factory plans to rebuild plant recently destroyed by fire. Estimated cost, $25,000. J. N. Gibson, Genl. Mgr.

Calif., Lodi—Trustees of the Lodi Union High School Dist., have awarded the contract for the construction of 1 story manual training shops. Estimated cost $44,750. Noted Nov. 13.

Calif., Los Angeles—Elk Manufacturing Co., 5012 South Main St., (auto bodies) is having plans prepared for the construction of a 1 story, 75 x 100 ft. factory and shop. Private plans.

Calif., Los Angeles—Pacific Meter Wks., M. K. Miller, Mgr., 2136 Atlantic St., plans the construction of a 2 story, 50 x 140 ft. factory on Atlantic St.

Calif., Los Angeles—Supervs. Los Angeles Co. have received bids for the construction of a machine shop at Baldwin Park. Noted Oct. 25.

Conn., Hartford—Capitol Buick Co., 236 Pearl St., has awarded the contract for the construction of a 2 story garage and service station at 80 Washington St. Estimated cost $150,000.

Ill., Rock Island—Chicago, Rock Island & Pacific R.R., 179 West Jackson Blvd., Chicago, awarded the contract for a 1 story addition to roundhouse. Estimated cost $40,000.

Mass., Lynn—R. T. Pender, 41 Sutton St., is having plans prepared for the construction of a 1 story, 160 x 50 ft. repair and service garage on Washington St. Estimated cost $40,000. Sanborn & Weed, 38 Exchange St., Archts.

Mich., Pontiac—Jewett Radio & Phonograph Co., 79 South Saginaw St., is having plans prepared for the construction of a 2 story, 50 x 210 ft. radio factory on Archard Lake Ave. Fisher Bros., 24 West Huron St., Archts.

Mich., Wyandotte—Regent Stove Co. plans the construction of a 1 story, 60 x 300 ft. stove factory. Estimated cost $50,000. C. W. Brandt, 1114 Kresge Bldg., Detroit, Mich., Archt.

Mo., St. Louis—Chandeysson Electric Co., 4092 Bingham Ave., is having preliminary plans prepared for a 50 x 240 ft. electric supply plant. Estimated cost $125,000. Widmer Engineering Co., Laclede Gas Light Bldg., Archt. and Engr.

Mo., St. Louis—More-Jones Brass & Metal Co., 314 North Bway., has awarded the contract for the general construction of a 1 and 2 story, brass foundry, to Fruin-Colnon Constr. Co., Merchants Laclede Bldg., Estimated cost $400,000.

N. Y., New York—R. Fulton, c/o J. M. Felson, archt., 250 West 57th St., having plans prepared for the construction of a 4 story garage, 509 West 34th St. Estimated cost $250,000.

Wis., Madison—The Jacobson Auto Co., 207 East Washington Ave., awarded the contract for the construction of a 2 story, 60 x 180 ft. garage. Estimated cost $150,000.